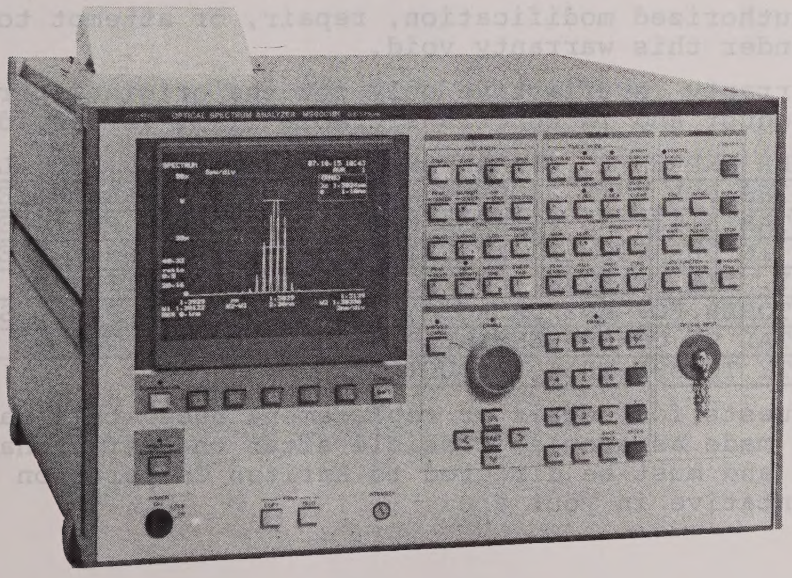
OPERATION MANUAL

OPTICAL SPECTRUM ANALYZER

MS9001B/B1



ANRITSU CORP.

CERTIFICATION

ANRITSU CORPORATION certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping.
Anritsu further certifies that its calibration measurements are based on the Japanese Electrotechnical Laboratory and Radio Research Laboratory standards.

WARRANTY

All parts of this product are warranted by Anritsu Corporation of Japan against defects in material or workmanship for a period of one year from the date of delivery. In the event of a defect occurring during the warranty period, Anritsu Corporation will repair or replace this product within a reasonable period of time after notification, free-of-charge, provided that: it is returned to Anritsu; has not been misused; has not been damaged by an act of God; and that the user has followed the instructions in the operation manual.

Any unauthorized modification, repair, or attempt to repair, will render this warranty void.

This warranty is effective only for the original purchaser of this product and is not transferable if it is resold.

ALL OTHER EXPRESSED WARRANTIES ARE DISCLAIMED AND ALL IMPLIED WARRANTIES FOR THIS PRODUCT, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO A PERIOD OF ONE YEAR FROM THE DATE OF DELIVERY. IN NO EVENT SHALL ANRITSU CORPORATION BE LIABLE TO THE CUSTOMER FOR ANY DAMAGES, INCLUDING LOST PROFITS, OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, ARISING OUT OF THE USE OR INABILITY TO USE THIS PRODUCT.

All requests for repair or replacement under this warranty must be made as soon as possible after the defect has been noticed and must be directed to Anritsu Corporation or its representative in your area.

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TABLE OF CONTENTS

INDEX 1 OPERATION MANUAL
OPTICAL SPECTRUM ANALYZER
MS9001B/B1

INDEX 2 GP-IB MANUAL
OPTICAL SPECTRUM ANALYZER
MS9001B/B1

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WARNING

NO OPERATOR SERVICEABLE PARTS INSIDE.
REFER SERVICING TO QUALIFIED PERSONNEL.

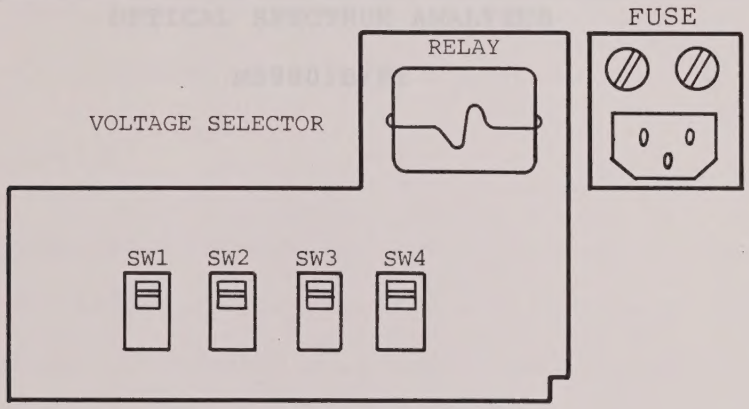
CAUTION

FOR CONTINUED FIRE PROTECTION REPLACE
ONLY WITH SPECIFIED TYPE AND RATED FUSE.

Notes:

1. The MS9001A Optical Spectrum Analyzer is operable on nominal voltages of 100, 115, 120, 200, 220, and 240 Vac by setting the VOLTAGE SELECTOR switches, fuses, and relay on the rear panel to match the ac power supply rating. (See paragraph 3.2.)

2. The power supply voltage rating is set as shown in the following figure.



AC	SW1	SW2	SW3	SW4	FUSE	RELAY (Coil Colour)
100 V					5 A (T5A250V)	Yellow (263A100/02CK)
115 V						
120 V						
200 V					3.15 A (T3.15A 250V)	Red (263A200/02CK)
220 V						
240 V						

3. In this manual, the power supply voltage and current ratings are represented by ** Vac and *** A, respectively.

CAUTION

Before changing power supply voltage rating or replacing fuses, always turn off the power switch and disconnect the power cord from the ac supply.

OPERATION MANUAL

OPTICAL SPECTRUM ANALYZER

MS9001B/B1

ANRITSU CORP.

TABLE OF CONTENTS

		Page
SECTION 1	GENERAL	1-1
SECTION 2	COMPOSITION AND SPECIFICATIONS	
2.1	Composition	2-1
2.1.1	Standard composition	2-1
2.1.2	Peripheral devices	2-2
2.2	Specifications	2-3
SECTION 3	OPERATION	
3.1	Introduction	3-1
3.2	Power Source	3-1
3.3	Ambient Conditions	3-3
3.3.1	Installation	3-3
3.3.2	Storage	3-4
3.4	Maximum Input Optical Level	3-4
3.5	Explanation of Controls	3-4
3.5.1	Panel layout	3-4
3.5.2	Explanation of controls	3-8
3.5.3	Explanation of MEASURE section (#4) controls	3-14
3.5.4	Explanation of DISPLAY section (#5) controls	3-17
3.5.5	Explanation of CONTROL SECTION (#7) controls	3-19
3.6	Explanation of CRT Display	3-21

TABLE OF CONTENTS (Cont.)

		Page
3.7	Operation Procedure	3-22
3.7.1	Preparation	3-22
3.7.2	Power on	3-23
3.7.3	Setting of measurement by spectrum auto ranging function	3-24
3.7.4	Setting of measurement by conversation function	3-24
	(1) Introduction	3-24
	(2) Procedure	3-25
	(a) Starting-up procedure	3-25
	(b) LD spectrum measurement procedure	3-26
	(c) LED spectrum measurement procedure	3-28
	(d) Loss measurement procedure	3-28
	(e) Transmission measurement procedure	3-31
3.7.5	Manual measurement condition setting	3-35
	(1) Wavelength setting	3-35
	(a) Wavelength setting using [START] and [STOP] keys	3-35
	(b) Wavelength setting using [CENTER] and [SPAN] keys	3-37
	(c) Wavelength setting using [PEAK → CENTER] key	3-39
	(d) Wavelength setting using [MARKER → CENTER] key	3-39
	(e) Wavelength setting using [ΔW → SPAN] key	3-40

TABLE OF CONTENTS (Cont.)

Page

(2) Level scale setting 3-41

(a) Level scale setting using [LINEAR] and [EXPAND] keys 3-41

(b) Level scale setting using [LOG] and [REFERENCE LEVEL] keys 3-43

(c) Level scale setting using [PEAK → LEVEL] key 3-44

(d) High sensitivity setting 3-46

(e) Optimum dynamic range setting .. 3-46

(3) Resolution setting 3-49

(a) Resolution setting by step keys 3-49

(b) Resolution setting by rotary knob 3-49

(c) Resolution setting by numeric keys 3-50

(d) Relationship between resolution and fiber core diameter 3-50

(4) Average time setting 3-51

(5) Sweep time setting 3-52

(6) Sweep mode setting 3-53

3.7.6 Manual display setting 3-54

(1) Trace mode setting 3-54

(2) Data memory setting 3-55

(3) Data recall and clear 3-56

(4) Marker setting 3-57

TABLE OF CONTENTS (Cont.)

		Page
4.2.2	Wavelength-loss characteristics measurement	4-22
	(1) Wavelength-loss characteristics measurement by conversation function	4-23
	(2) Wavelength-loss characteristics measurement by manual operation	4-24
4.3	Measuring Time	4-26
SECTION 5	PRINCIPLES OF OPERATION	
5.1	Overall	5-1
5.2	Light Diffraction Section	5-2
5.3	Diffraction Grating Drive Section	5-3
5.4	Optical Receiving Section	5-4
5.5	Processing Section and CRT	5-5
SECTION 6	PERFORMANCE TEST	
6.1	Introduction	6-1
6.2	Equipment Required for Performance Tests ...	6-2
6.3	Preparation	6-4
6.4	Performance Test	6-5
6.4.1	Measuring wavelength range	6-5
6.4.2	Measuring level range	6-6

TABLE OF CONTENTS (Cont.)

		Page
6.4.3	Measuring level accuracy	6-8
6.4.4	Linearity	6-9
6.4.5	Dynamic range (Stray light level)	6-10
6.4.6	Wavelength accuracy	6-12
6.4.7	Resolution bandwidth	6-14
6.4.8	Memory backup function	6-17
APPENDIX A	OPTIONAL ACCESSORIES	A-1
APPENDIX B	MA919B PARALLEL BEAM MOUNT	B-1
APPENDIX C	MP915A FIBER ADAPTER	C-1
APPENDIX D	MA918A LIGHT EMITTING ELEMENT MEASURING UNIT	D-1
APPENDIX E	MG922A WHITE LIGHT SOURCE	E-1
APPENDIX F	PACKET V PERSONAL TECHNICAL COMPUTER	F-1
APPENDIX G	POLAROID CAMERA	G-1
APPENDIX H	MB23A PORTABLE TEST RACK	H-1

SECTION 1

GENERAL

The MS9001B/B1 Optical Spectrum Analyzer is a high-speed, accurate instrument designed to measure luminous spectra of laser diodes (LDs) or LEDs, and wavelength characteristics, by using a whitelight source in the wavelength range of 0.6 to 1.75 μm. Measurements are displayed on a built-in CRT.

It uses the dispersion spectrophotometric method.

Its features are described below.

(1) Wide dynamic range and excellent linearity

The dispersion spectrophotometric method, enables photoelectric conversion in which the displayed level corresponds to the light level received by the conversion device after the incident light has been divided. For this reason, difficult-to-measure (through use of the Fourier spectrophotometric method) light at low levels close to intense light can be accurately measured at a high S/N ratio. Moreover, linearity is also guaranteed over a wide level range and the side-mode ratio of DFB laser can be measured with high accuracy.

(2) High-speed measurement

Since the minimum sweeptime is about 0.3 s, mode hopping and chirping can be routinely measured at high speed. This short period is maintained even if the measurement conditions are changed during the sweep. Consequently optimum conditions can be searched for while verifying the respective changes. Measurement in the log mode has been greatly speeded up in comparison to previous ANRITSU spectrum analyzers, by use of a high-speed range changeover circuit (patent pending). Measurement can be

made within 7 seconds (5 times faster than previous ANRITSU spectrum analyzers) over the entire wavelength range (span: 0.6 to 1.7 resolution: 5 nm).

(3) High sensitivity

-70 dBm light is measured in the range of 0.7 to 1.6 μm. Wavelength-loss characteristics of SM fiber can also be adequately measured. The maximum measurement level is +10 dBm.

(4) Guaranteed level accuracy

A level accuracy of ±2 dB is guaranteed. Since level measurement does not depend on the polarization characteristics, level comparisons between devices, and absolute level measurement of different modes, can be made.

(5) Measurement by spectrum auto-ranging function

An unknown light signal is searched for and the measurement condition is set to the optimum automatically. By use of this function, measurement can be made without setting the wavelength, level, and resolution.

(6) Measurement by conversation function

By selecting the measurement item displayed on the CRT, the other conditions required for the measurement can be set automatically.

(7) Half-bandwidth auto reading function

Measurement of the half-spectral bandwidth is instantly carried out.

(8) Simple measurement condition change

Measurement condition changes can be easily made; for example, changing the peak wavelength to the center wavelength, the marker wavelength to the center wavelength, the width between the two wavelength markers to span, and the peak level to the reference level. Complicated key operations have been reduced to a one-touch key operation for condition changes.

(9) Built-in printer

Measured results are printed out. Measurement can also be made during printer output.

(10) GP-IB (Standard equipment)

The measuring system has been updated by using the GP-IB.

The main measurement items are as follows:

(1) Luminous spectra

(2) Wavelength-loss characteristics (white light source is required)

Refer to Table 1-1 for the main objects of measurement and items to be measured, and for the peripheral devices.

Table 1-1 Measurement Objects

Object	Items to be measured	Peripheral devices	Paragraph reference
LD	Luminous spectra (Center wavelength, half-bandwidth, side-mode ratio, vertical mode number)	Measurement optical fiber, fiber with front-end lens	4.1

Table 1-1 Measurement Objects (Cont.)

Object	Items to be measured	Peripheral devices	Paragraph reference
LED	Emission spectrum center wavelength and half-bandwidth	Measurement optical fiber, fiber with front-end lens	4.1
Optical fiber	Wavelength-loss characteristics	White light source (MG922A)	4.2
Optical fiber, optical attenuator	Wavelength-loss characteristics	White light source (MG922A) Measurement optical fiber (2 pcs) Parallel beam mount (MA919B)	4.2

This manual has the five sections and appendix outlined below:

- SECTION 1 GENERAL

  Outline of instrument and composition of operation manual

- SECTION 2 COMPOSITION AND SPECIFICATIONS

  Composition, peripheral devices, and specifications

- SECTION 3 OPERATION

  Installation precautions, safety measures, explanation of controls, and operating instructions

- SECTION 4 MEASUREMENT

  Measurement setup and procedures

- SECTION 5 PRINCIPLES OF OPERATION

  Circuit description by block diagrams

- APPENDIX

  Optional accessories and pheripheral devices

SECTION 2

COMPOSITION AND SPECIFICATIONS

2.1 Composition

2.1.1 Standard composition

The standard composition of this instrument is listed in Table 2-1.

Table 2-1 Standard Composition

Item	No.	Name	Qty.	Remarks
Equipment	1	MS9001B/B1 Optical Spectrum Analyzer	1	
Accessories	2	Power switch key	2	
	3	Power cord	1	
	4	Fuse	2	*** Aac
	5	Operation manual	1	
	6	Service manual	1	
	7	Printer paper	2	
	8	GP-IB cable	1	

2.1.2 Peripheral devices

Table 2-2 Peripheral Devices

Name	Remarks	Paragraph reference
Measurement cable	Connects optical connectors	APPENDIX-A
Optical Fiber with Front-end Lens	This fiber has a lens at one end and an optical plug at the other. It effectively collects parallel light transmitted through free space.	APPENDIX-A
MA919B Parallel Beam Mount	This mount emits light from an optical fiber into the free space, forms it into a parallel beam, and then returns it to an optical fiber. The wavelength-loss characteristics can be measured by inserting a filter between the two fibers.	APPENDIX-B
Large diameter optical fiber cord	Fiber composed of multi-component glass with core diameter of 200, 400, 600, or 800 µm.	APPENDIX-A
MP915A Optical Fiber Adapter	A pig tail fiber can be attached and temporarily used in place of a plug.	APPENDIX-C
MA918A Light Emitting Element Measuring Unit	This unit is used to measure spectral characteristics of optical elements that are not coupled to a connector. An element can be installed in one simple operation, permitting immediate connection with optical fibers. Compatible heads are available for a variety of optical elements.	APPENDIX-D
Accessory	Use a protective panel cover.	

2.2 Specifications

Table 2-3 Specifications

	MS9001B	MS9001B1
Wavelength range	0.6 to 1.75 µm	
Level measuring range	+10 to -70 dBm (0.7 to 1.6 µm) *1 +10 to -65 dBm (0.6 to 0.7 µm) *1 +10 to -55 dBm (1.6 to 1.75 µm) *1	
Measuring level accuracy	±2 dB (0.85, 1.3, 1.55 µm) *2	
Linearity	±3 dB/60 dB ±1 dB/20 dB ±0.5 dB/10 dB	
Level display range	0.2, 0.5, 1, 2, 5, 10 dB/div and LINEAR	
Stray light level	< -35 dB *3 < -45 dB *4	< -45 dB *3 < -50 dB *5
Wavelength reading resolution	2 pm	
Wavelength accuracy	±1 nm (10° to 40°C), ±0.5 nm (25°C)	
Resolution bandwidth	0.1, 0.2, 0.5, 1, 2, 5 nm	
Wavelength sweep width	0, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100 nm/div	
Sweep time	< 0.3s (Sweep width < 2 nm) *6 < 1s (Sweep width < 50 nm) *6 < 3s (Sweep width < 500 nm) *6 < 7s (Sweep width < 1200 nm) *6	
Processing function	Automatic optimum measuring condition setting function, title display, time display, waveform analysis function, read out of half width of spectrum, peak search, peak to center, memory back-up, signal subtraction function, averaging function, wavelength calibration function.	
Remote control	GP-IB (IEEE488, IEC625-1, 24 pins) SH1, AH1, T8, L4, RL1, SR1, PP0, DT1, DC1, C0 All functions (except power, intensity, wavelength calibration, and address switch) are remotely controllable.	

Table 2-3 Specifications (Cont.)

Printing and video output	CRT information can be plotted by built-in printer, and displayed by external video monitor with video output
Direct plotting	The CRT screen can be directly output to a digital plotter (HP mode 1 7475A, 7550A) *7 with a GP-IB (HP-IB) cable.
Dimmensions and weight	266 H x 426 W x 450 D mm, $\leqq$ 30 kg
Ambient temperature, rated range of use	10° to 40°C
Power	** Vac ±10% (max. 250 V), 48 to 63 Hz, $\leqq$ 250 VA

*1 Power level involved in resolution bandwidth except 0.1 and 0.2 nm.

*2 For SM fiber, -30 dBm, and resolution bandwidth 0.2 to 5 nm

*3 Difference between peak level and level at ±1 nm on either side of peak for SM fiber, resolution bandwidth 0.1 nm, and wavelength 1.1523 and 1.523 µm

*4 Difference between peak level and level at ±10 nm an either side of peak for SM fiber, resolution bandwidth 0.1 nm, and wavelength 1.1523 and 1.523 µm

*5 Difference between peak level and level at ±5 nm an either side of peak for SM fiber, resolution bandwidth 0.1 nm, and wavelength 1.1523 and 1.523 µm

*6 For single averaging time and measuring range >-30 dBm (1 µW)

*7 ANRITSU does not handle the plotter. Direct purchase from the HP is requried.

SECTION 3

OPERATION

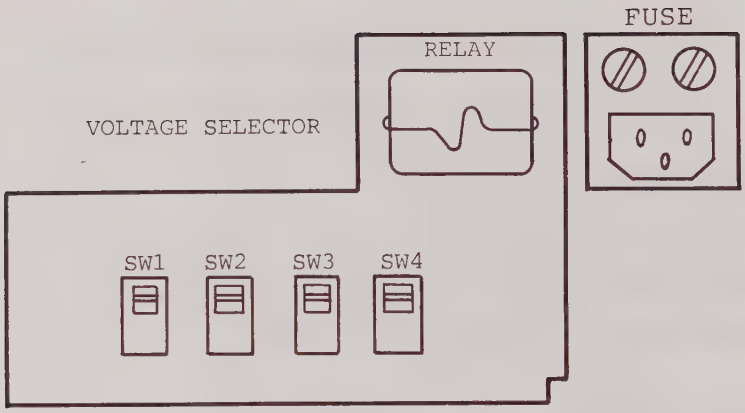
3.1 Introduction

This section describes the power source, environmental conditions, control, measurement preparations, and measurement condition settings.

3.2 Power Source

Set the VOLTAGE SELECTOR on the rear panel, to use the MS9001B/B1 at nominal voltages of 100, 115, 120, 220, and 240 Vac, in the frequency range of 48 to 63 Hz.

The relationship between the line voltage, VOLTAGE SELECTOR, fuses, and relays is given in Fig. 3-1. Set the VOLTAGE SELECTOR switch, fuses, and relays according to the line voltage.



AC	SW1	SW2	SW3	SW4	FUSE	RELAY (Coil Colour)
100 V					5 A (T5A250V)	Yellow (263A100/02CK)
115 V						
120 V						
200 V					3.15A (T3.15A 250V)	Red (263A200/02CK)
220 V						
240 V						

Fig. 3-1 Voltage Selector, Fuse, and Relay Settings

WARNING

To avoid accidental electric shock, when using a 2-pin power outlet, always ground the rear panel ground terminal (⏚) or the power cord ground terminal.

WARNING

Before changing the power supply voltage rating or replacing fuses, always turn off the power switch and disconnect the power cord from the ac supply.

3.3 Ambient Conditions

3.3.1 Installation

This instrument is designed to operate normally in an ambient temperature range of 10° to 40°C. For best operation, however, it should be used at normal room temperature whenever possible. Do not use or store the instrument in locations where:

1. Vibrations are severe
2. It is damp or dusty
3. There is exposure to direct sunlight
4. There is exposure to active gases
5. There is exposure to magnetism
6. Oxidation or rusting may occur
7. The instrument can easily be overturned.

CAUTION

If this instrument is operated at room temperature after being used for a long period at low temperatures, condensation may occur and cause short-circuiting. To prevent this, do not turn the power on until the instrument is completely dry.

3.3.2 Storage

(1) Recommended storage conditions

The instrument should be stored in a temperature range of 0° to 30°C, and a humidity range of 40% to 80%. It should be cleaned and packed in a box or a cover sheet before storage. The storage area should not be subject to large fluctuations in temperature and humidity over a 24-hour period.

(2) Precautions following storage

See previous caution about condensation. Check the ventilator fan and ensure nothing is obstructing it; also check for dust.

3.4 Maximum Input Optical Level

CAUTION

Do not input optical signals at levels higher than +15 dBm.

The maximum input optical level of this instrument is +15 dBm. (The maximum optical level that can be displayed is +10 dBm.) If optical signals above this level are input, the instrument will be damaged.

3.5 Explanation of Controls

3.5.1 Panel layout

Figs. 3-2 to 3-4 show the layout of keys and connectors of the MS9001B/B1.

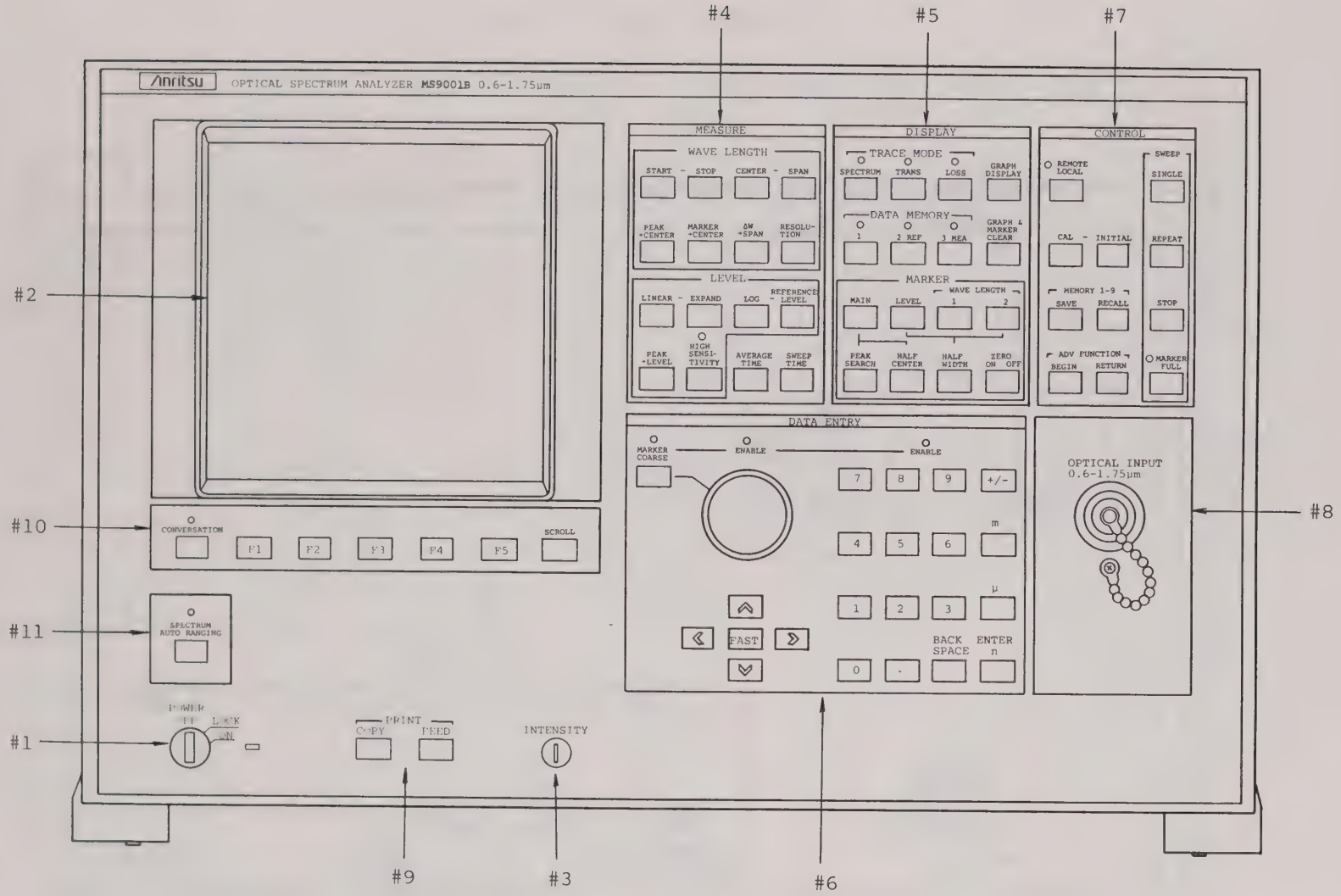


Fig. 3-2 Front Panel

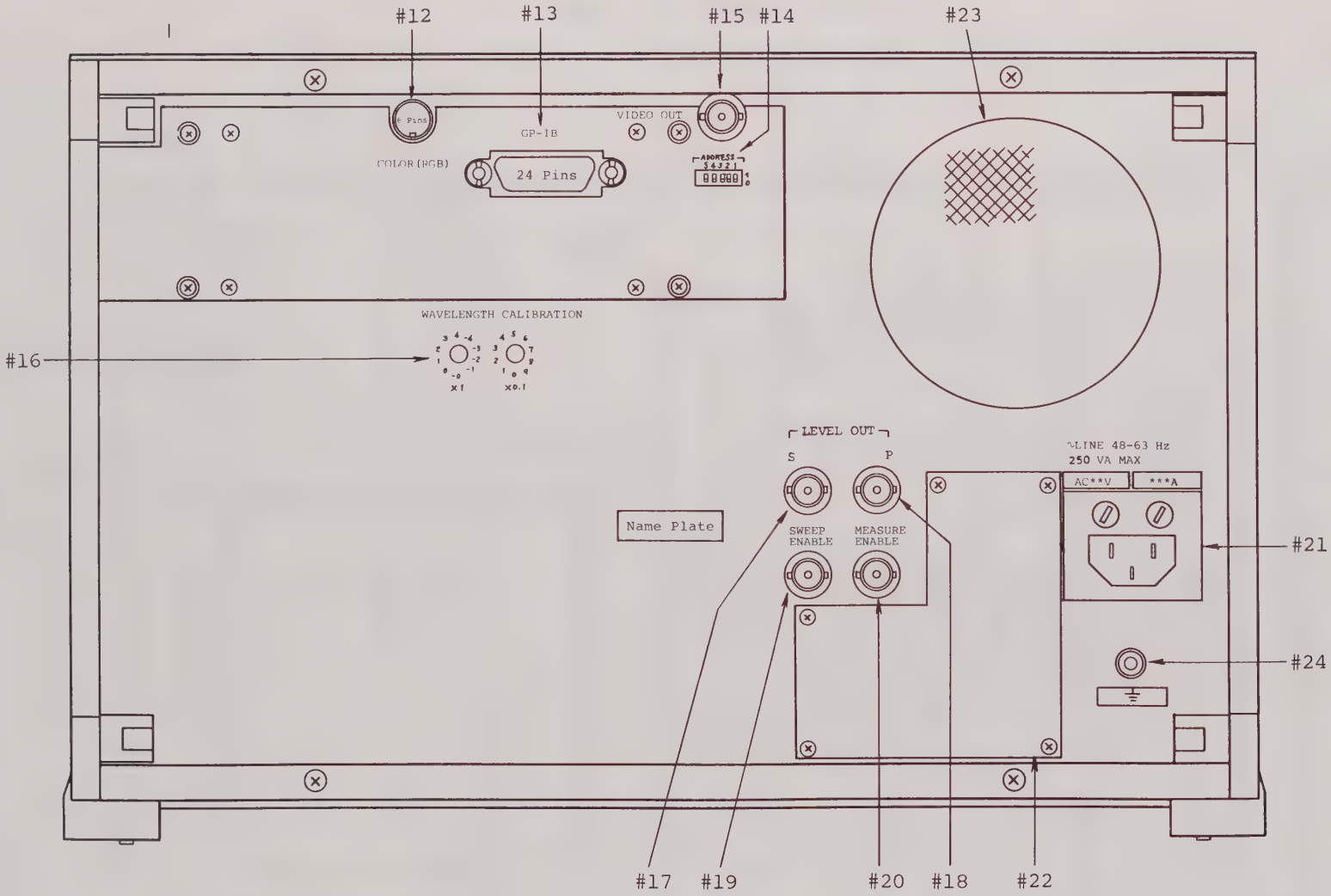


Fig. 3-3 Rear Panel

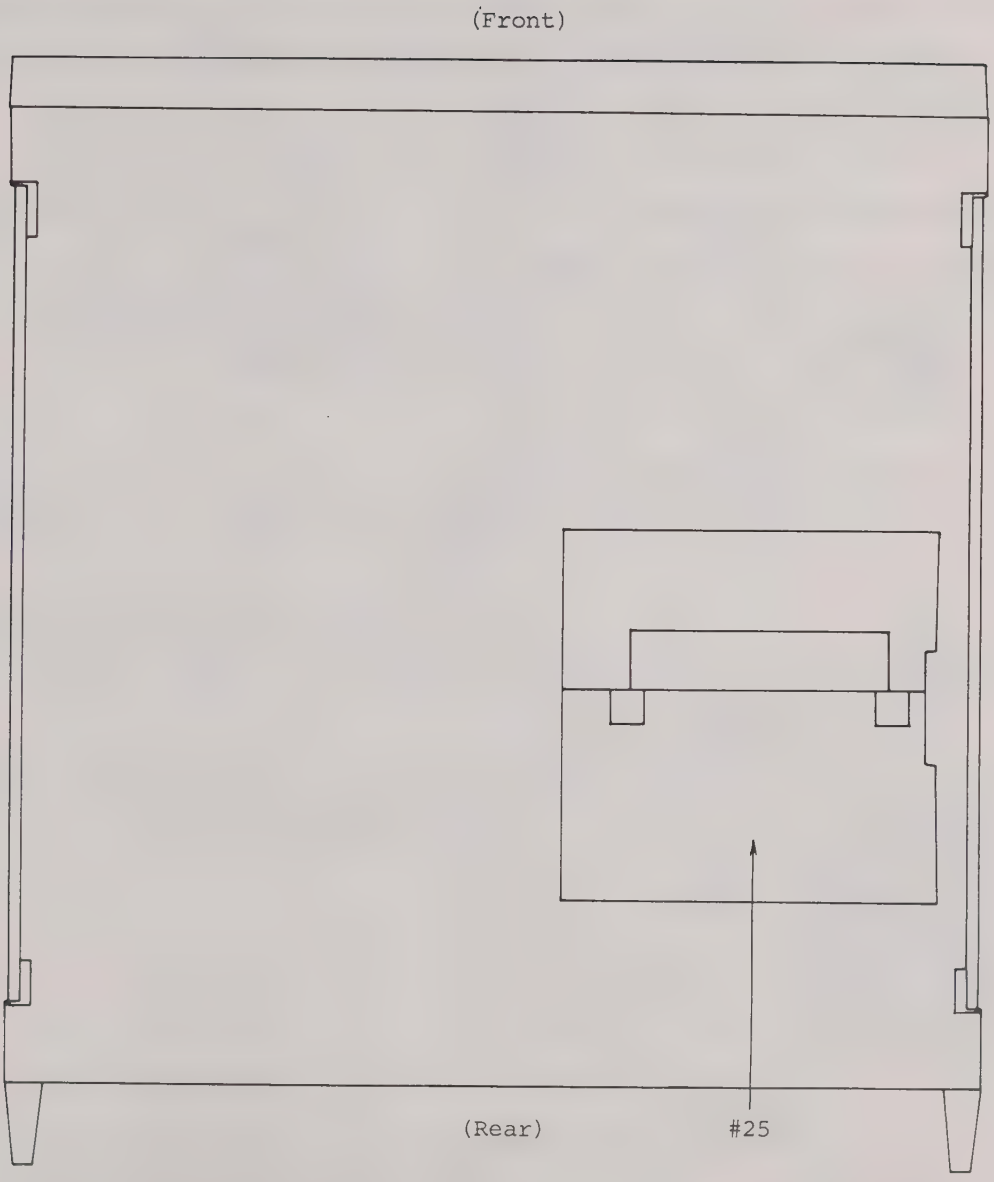


Fig. 3-4 Top View

3.5.2 Explanation of controls

The keys are explained in Table 3-1. Numbers marked with an # in the table are the same as in Figs. 3-2 to 3-4.

Table 3-1 Explanation of Controls

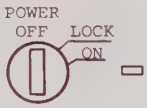
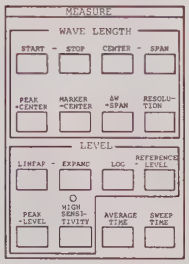
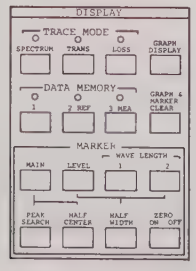
No.	Label	Explanation
#1	 POWER	On/off switch for power supply. When power is supplied, the lamp on the right side lights.
#2	CRT	Displays the observation waveforms, measurement conditions, and measured results
#3	 INTENSITY	Adjusts the CRT brightness; turn to the right for a brighter display and to the left for a darker display
#4	 MEASURE	Sets the measurement conditions for the wavelength, level, and resolution
#5	 DISPLAY	These keys set the data and mode for display on the CRT.

Table 3-1 Explanation of Controls (Cont.)

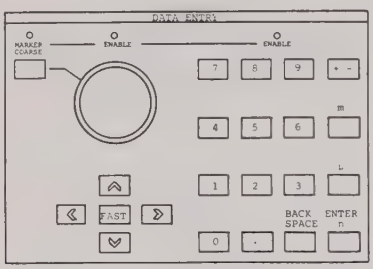
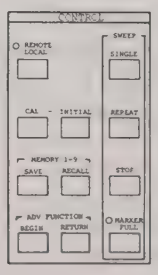
No.	Label	Explanation
#6	 DATA ENTRY	These keys and knob are used with the MEASURE and DISPLAY keys for numeric data settings of the measurement conditions. They include rotary knob; step keys; and numeric keys. The ENABLE lamp over each key or knob lights when key entry can be performed. To end input entry from numeric keys, press the [m], [μ], or [ENTER n] keys. When the units entry is faulty, "unit error" is displayed on the CRT. The [MARKER COARSE] key enables the marker to be fast-forwarded by the rotary knob. Note: Turn the rotary knob clockwise or press the [≫] key for up and turn the rotary knob counterclockwise or press the [≪] key for down. However, when setting the wavelength, resolution, and level scale, turn the rotary knob counterclockwise or press the [≪] key for up and turn the rotary knob clockwise or press the [≫] key for down.
#7	 CONTROL	These keys start and stop sweep, and set the memory transfer of the measurement conditions.

Table 3-1 Explanation of Controls (Cont.)

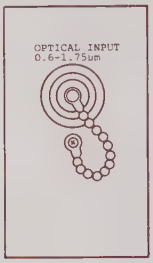
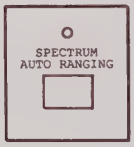
No.	Label	Explanation
#8	 OPTICAL INPUT	Optical input connector
#9	PRINT	Used when printing out hard copies of the CRT at the built-in printer
#10	SOFT KEY	These soft keys are used for measurement by conversation function and for ADVANCED FUNCTION mode. (The SCROLL key is not usable.)
#11	 SPECTRUM AUTO RANGING	Used for automatic spectrum measurement. The LED above the key lights during automatic measurement.
#12	COLOR (RGB)	RGB output connector for external color monitor TV

Table 3-1 Explanation of Controls (Cont.)

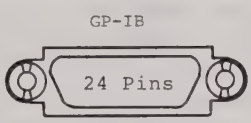
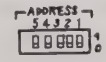
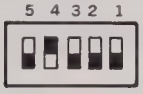
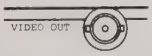
No.	Label	Explanation
#13	 GP-IB	GP-IB connector
#14	 ADDRESS	GP-IB address switches. At shipment, these are set to address 8 as shown below.  (16, 8, 4, 2, 1)
#15	 VIDEO OUT	Connector for external video display A voltage of approx. 1 V p-p is output to a 75 Ω load.
#16	 WAVELENGTH CALIBRATION	Simplified wavelength calibration switches. These can be set from -4.9 to +4.9 nm in steps of 0.1 nm.
#17	 LEVEL OUT-S	Analog output terminal of the optical input polarized S component. +1 Vdc is output at each full scale of the log ranges (+10, 0, -10, -20, ... dBm; 10 dB steps) and the linear scale ranges (100 mW, 10 mW, 1 mW, 100 µW, ... 10 pW). The output level at each full scale of other ranges decreases in proportion to each full scale value of the range.

Table 3-1 Explanation of Controls (Cont.)

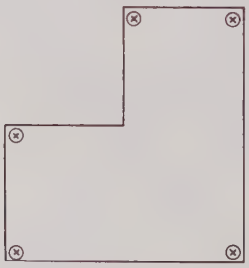
No.	Label	Explanation
#18	LEVEL OUT-P	Analog output terminal of the optical input polarized P component. +1 Vdc is output at each full scale of the log ranges (+10, 0, -10, -20, ... dBm; 10 dB steps) and the linear scale ranges (100 mW, 10 mW, 1 mW, 100 µW, ... 10 pW). The output level at each full scale of other ranges decreases in proportion to each full scale value of the range.
#19	SWEEP ENABLE SWEEP ENABLE	External trigger input terminal for starting sweep. Sweep starts at TTL high level.
#20	MEASURE ENABLE MEASURE ENABLE	External trigger input for measurement (sampling). At TTL high level, sampling is carried out; at low level, sampling is not carried out.
#21		The ac power supply inlet and fuses are built-in. Use fuses with ratings specified according to the input voltage.
#22	 VOLTAGE SELECTOR	Cover for line voltage setting assembly. By changing the VOLTAGE SELECTOR switch setting and relay, the line voltage rating can be changed.

Table 3-1 Explanation of Controls (Cont.)

No.	Label	Explanation
#23	FAN	This fan exhausts heat, generated by the circuits, to the outside. Do not obstruct the exhaust port.
#24		Ground terminal; to avoid accidental electrical shock, ground this terminal.
#25		Built-in printer (paragraph 3.7.8)

3.5.3 Explanation of MEASURE section (#4) controls

The keys in this section set the measurement conditions for the wavelength, level, resolution, and average time.

Table 3-2 Explanation of MEASURE Section (#4) Controls

Key	Explanation
START	Sets the minimum value (start wavelength) of the measurement wavelength
STOP	Sets the maximum value (stop wavelength) of the measurement wavelength
CENTER	Sets the center value (wavelength) of the measurement wavelength
SPAN	Sets the sweep width (span) of the measurement wavelength. The settable span widths are as follows: 1200, 1000, 500, 200, 100, 50, 20, 10, 5, 2, 1, and 0 nm
PEAK → CENTER	Changes the peak wavelength on the CRT screen to the center wavelength
MARKER → CENTER	Changes the wavelength of the main marker to the center wavelength
Δ W → SPAN	Half the sum of the wavelengths of wavelength markers 1 and 2 is set as the center wavelength, and the width between markers 1 and 2 is set as the span. However, the span can only be set as discrete step values (above span width). When the width differs from the discrete value, span is set to the nearest span width over the width between the two markers.

Table 3-2 Explanation of MEASURE Section (#4) Controls (Cont.)

Key	Explanation
W → SPAN (cont.)	Examples: 1. When the width between wavelength markers 1 and 2 is 20 nm, pressing this key makes the span 20 nm. 2. When the width between wavelength markers 1 and 2 is 25 nm, pressing this key makes the span 50 nm.
RESOLUTION	Sets wavelength resolution; settable resolutions are: 5, 2, 1, 0.5, 0.2, and 0.1 nm.
LINEAR	Sets the linear scale range; settable ranges are: 100 mW, 50 mW, 20 mW, 10 mW, 5 mW, 2 mW, 1 mW, 500 µW, 200 µW, 100 µW, 50 µW, 20 µW, 10 µW, 5 µW, 2 µW, 1 µW, 500 nW, 200 nW, 100 nW, 50 nW, 20 nW, 10 nW, 5 nW, 2 nW, 1 nW, (500 pW, 200 pW, 100 pW, 50 pW, 20 pW, 10 pW) Note: Range of ( ) can be set only by the rotary knob.
EXPAND	Permits magnified display of linear scale. Magnifications up to 2 times are routine.
LOG	Sets the log scale range; settable ranges are: 10, 5, 2, 1, 0.5, and 0.2 dB/div
REFERENCE LEVEL	Sets the maximum value on the log scale display (on the most upper horizontal line of scale).

Table 3-2 Explanation of MEASURE Section (#4) Controls (Cont.)

Key	Explanation
PEAK → LEVEL	Sets the level scale in accordance with the peak value of the measurement waveform. At linear scale, it is set to the nearest upper range, when the peak value differs from the discrete range value. Example: Linear scale range is set to the 100 µW at the peak value of 70 µW. At log scale, the reference level is set to the nearest upper discrete value by a step of dB/div value, when the peak value differs from the discrete value. Example: When the peak value is -17.6 dB, the reference level is set to -10 dB if 10 dB/div is set, and to -15 dB if 5 dB/div is set.
HIGH SENSITIVITY	Sets high sensitivity measurement while chopping the input light. The over above the key lights when this mode is used. Press the key again to leave this mode.
AVERAGE TIME	Sets the number of averagings in the range from 1 to 1,000 times.
SWEEP TIME	Switches the sweep time between NORMAL and FAST. NORMAL → FAST In FAST mode, FAST is displayed on the upper left of the CRT.

3.5.4 Explanation of DISPLAY section (#5) controls

The keys in this section are related to display of the trace mode, data memory, and marker on the CRT.

Table 3-3 Explanation of DISPLAY Section (#5) Controls

Key	Explanation
	These keys select one of three trace modes: SPECTRUM, TRANS (mission), and LOSS. The LED over the selected mode lights. The selected mode is displayed at the upper left of the CRT.
GRAPH DISPLAY	Plots the waveform stored in the data memory.
	Selects one of the three data memories 1 to 3. The measurement conditions and observation waveforms are stored in each data memory; the LED over the selected memory lights. Memories No. 2 (REF) and 3 (MEA) are used when subtraction operation is carried out in the TRANS or LOSS mode.
GRAPH & MARKER CLEAR	Erases the graph (displayed waveform) and marker from the CRT
MAIN	Sets the main marker with a cursor (*). The cursor (*) is shifted on the waveform; the level is displayed at the left of the scale, and the wavelength (Wm) is displayed at the bottom of the scale.
LEVEL	Sets the level marker with a broken horizontal line. The marker level is displayed at the left of the scale.
	Sets the wavelength markers 1 and 2 with two broken vertical lines. The marker wavelengths (W1, W2) are displayed at the bottom of the scale. Note: Wavelength markers 1 and 2 cannot be set so that they intersect. (Start wavelength $\leq$ Wavelength marker 1 $\leq$ Wavelength marker 2 $\leq$ stop wavelength)

Table 3-3 Explanation of DISPLAY Section (#5) Controls (Cont.)

Key	Explanation
PEAK SEARCH	Displays the main marker at the peak of the waveform. The peak level is displayed at the left of the scale, and the peak wavelength (Wp) at the bottom.
HALF CENTER	Displays the main marker at the center wavelength of the half width. The peak level is displayed at the left of the scale, and the center wavelength (Wc) at the bottom.
HALF WIDTH	Displays the half width. The level marker and wavelength markers 1 and 2 are displayed at the half value position of the peak; the half width (W2 - W1) is displayed at the bottom of the scale.
ZERO ON OFF	Displays the zero marker (reference marker with a cursor (+)) at the main marker position. The cursor (+) is fixed and only the main marker (*) can be shifted. The level ratio (linear scale) or the level difference (log scale) is displayed at the left of the scale; the wavelength difference (Wn) is displayed at the bottom. OFF → ON →

3.5.5 Explanation of CONTROL section (#7) controls

The key in this section set the memory transfer of the measurement conditions, screen initialization, and selection of the sweep mode.

Table 3-4 Explanation of CONTROL Section (#7) Controls

Key	Explanation
o REMOTE LOCAL	Changes remote control to local control. The REMOTE lamp lights when the external controller is used. The keys on the panel are enabled in LOCAL status. Note: Remote cannot be changed to local in the local lock-out status.
CAL	Calibrates level. The level marker value is calibrated so that it becomes a 10-key input value. The displayed waveform and level marker are then re-displayed. Note: An operation error will occur if the level marker is not set in advance.
INITIAL	Returns the CRT display (measurement conditions) to the status after power on.
⌜ MEMORY 0-9 ⌝ SAVE RECALL	Ten measurement conditions can be stored in the memory. The [SAVE] key stores conditions; the [RECALL] key recalls them.
⌜ ADV FUNCTION ⌝ BEGIN RETURN	These keys set the advanced function. The [BEGIN] key starts the setting; the [RETURN] key ends it.
SINGLE	Sets one sweep from the start wavelength to the stop wavelength
REPEAT	Sets repeated sweeps. When this key is pressed at sweep stopped status, the sweep is continued from the point where it was stopped. When it is pressed during sweep operation, the sweep is performed from the start wavelength.

Table 3-4 Explanation of CONTROL Section (#7) Controls (Cont.)

Key	Explanation
STOP	Stops sweep
o MARKER FULL	Sets sweep range At the FULL setting (WAVELENGTH MARKER off), the entire range (from the start wavelength to the stop wavelength) is swept. At the WAVELENGTH MARKER setting, the LED over the lamp lights and only the range between wavelength markers 1 and 2 is swept.

3.6 Explanation of CRT Display

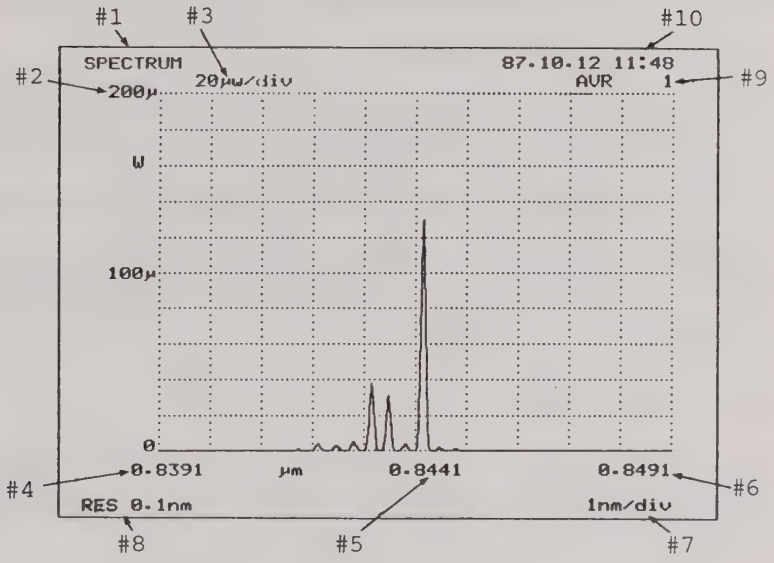


Fig. 3-5 CRT Display

#1	Measuring mode	SPECTRUM, TRANS, and LOSS modes provided
#2	Level setting range	LINEAR and LOG modes both provided
#3	Level scale	Level/div (vertical axis) displayed
#4	Start wavelength	Wavelength displayed at left side of CRT
#5	Center wavelength	Wavelength displayed at center of CRT
#6	Stop wavelength	Wavelength displayed at right end of CRT
#7	Wavelength scale	Wavelength/div (horizontal axis) displayed
#8	Resolution	Resolution displayed
#9	Number of averaging operations	Number of averagings displayed
#10	Time	Time displayed

3.7 Operation Procedure

3.7.1 Preparation

Check the following items prior to measurement.

1. Ambient temperature

   This instrument remains within specifications in an ambient temperature range of 0° to +40°C. Do not use the instrument outside this temperature range, or in rapidly changing temperature conditions. If water gets on the surface of the cabinet, it should be dried immediately (Paragraph 3.3).

2. Ac line voltage

   Check that the ac line voltage matches the power supply voltage indicated on the rear panel (Paragraph 3.2).

3. Ground terminal

   Always ground the ground terminal on the rear panel to prevent accidental electric shock when using the instrument.

4. Installation site

   Since this instrument has a CRT, do not use it where there are strong vibrations or where it can fall over.

5. Cleaning optical connector surface

   Clean the optical connector surface and optical fiber plug surface with a soft cloth prior to the measurement if necessary.

6. More than 30 minutes warm-up is required for stable measurement results.

3.7.2 Power on

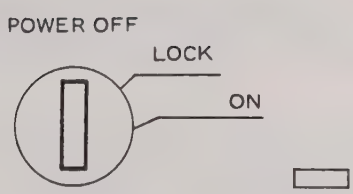


Fig. 3-6 POWER Switch

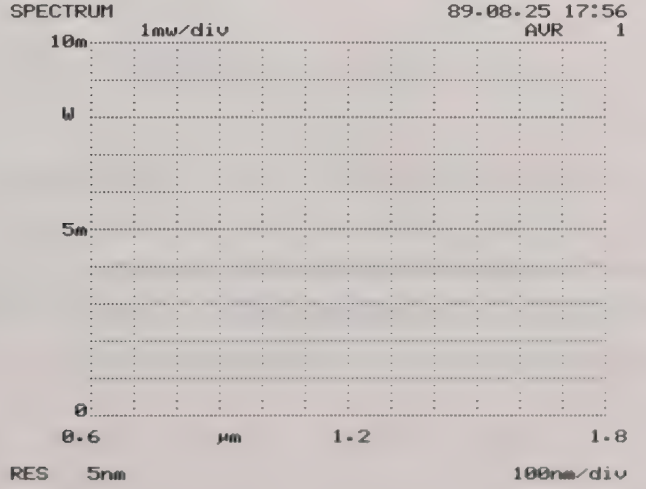
The POWER switch has three modes. The power switch key, selects one of them.

(1) OFF: The power is off; the key can be removed or inserted.

(2) LOCK: The power is on and the lamp on the right is lit. The keys on the panel cannot be operated; the key can be removed or inserted.

(3) ON: The power is on and the lamp on right is lit. All keys on the panel can be operated but the key cannot be removed or inserted.

The initial state at power on is shown below.



3.7.3 Setting of measurement by spectrum auto ranging function

This function enables measurement of the spectrum of a mono-chromatic light source and stores the data in data memory 1.

Press the [SPECTRUM AUTO RANGING] key to start measurement; the MS9001B/B1 measures several times and automatically sets the center wavelength, span, level scale, and resolution to optinum value.

Notes:

1. The number of averaging times is one.

   The data memory is 1.

2. Only mono-chromatic light can be measured; LD or LED light sources can be measured.

   The light sources listed below cannot be measured:

   1. Multiplexed light source by optical coupling with more than two light sources
   2. White light source with wide wavelength band
   3. Mercury and fluorescent lamps with multi-spectra

3.7.4 Setting of measurement by conversation function

(1) Introduction

This measurement is performed by pressing the soft keys and changing the measuring setup in response to the message displayed on the CRT. The user can then easily make measurements without having to remember the measuring procedures.

Notes:

1. This paragraph explains the typical measurement.

   Refer to paragraphs 3.7.5 to 3.7.7 for detailed measuring condition settings by manual operation.

2. In the measurement by conversation function, the measuring condition is automatically set by soft key operation. If the measuring condition is set by keys other than the soft keys, the measuring state may become abnormal. In that case, press the [INITIAL] key to reset the condition.

(2) Procedure

(a) Starting-up procedure

Step	Procedure
1	Press [CONVERSATION] key to measure by conversation function. The following message is displayed: What do you want to measure? F1: LD SPECTRUM F2: LED SPECTRUM F3: LOSS of FIBER etc F4: TRANSMISSION of FILTER etc F5: END The characters which indicate the soft key function, are displayed at the bottom of the CRT corresponding to the soft key layout. [LD] [LED] [LOSS] [TRANS] [END] F1 F2 F3 F4 F5

(Cont.)

Step	Procedure
2	Press desired soft key. Notes: 1. Press the [F1] key to measure FD spectrum. Press the [F2] key to measure LED spectrum. Press the [F3] key to measure loss-wavelength characteristics. Press the [F4] key to measure the transmission-wavelength characteristics. Press the [F5] key to end measurement. 2. When F1, F2, F3, F4, or F5 is selected, the procedure is continued to paragraph (b), (c), (d), (e) or (f), respectively.

(b) LD spectrum measurement procedure

This procedure is continued from paragraph (a).

Step	Procedure
1	Press [F1] soft key. The following message and soft keys are displayed: LD wavelength? [?] [0.85] [1.3] [1.55] [END]

(Cont.)

Step	Procedure
2	Press desired soft key. Notes: Press [?] key for unknown wavelength Press [0.85] key for 0.85 μm wavelength. Press [1.3] key for 1.3 μm wavelength. Press [1.55] key for 1.55 μm wavelength. Press [END] key to end LD spectrum measurement. Example: If the [1.3] key [F3] is pressed, the next message is displayed. LD 1.3 measuring The measuring condition for 1.3 μm LD light source is automatically set and measurement starts. When the measurement ends, the following message and soft key are displayed. LD 1.3 end [NEXT] [END]
3	Press [NEXT] key after changing light source to another one of the same wavelength to be measured. Or press [END] key to change measuring wavelength.

(c) LED spectrum measurement procedure

The procedure is the same as that of paragraph (b) except that an LED is used.

(d) Loss measurement procedure

This procedure is continued from paragraph (a).

Step	Procedure
1	Press [F3] soft key. The following message and soft key are displayed. WAVELENGTH ok? [YES] [RECALL] [END]
2	Press desired soft key. Note: Press the [YES] key when the wavelength range is OK. Press the [RECALL] key to recall the wavelength range from data memory 3 which stores the wavelength data of the previous loss measurement. For new wavelength range, set the wavelength (paragraph 3.7.5 (1)) and press the [YES] key. Press the [END] key to end loss measurement. Example: When the [YES] or [RECALL] key is pressed, the next message and soft key are displayed to connect the short fiber for measuring the loss characteristics of the measurement system. Connect SHORT FIBER ok? [YES] [END]

(Cont.)

Step	Procedure
3	Connect the MS9001B/B1 to a white light source by using a short fiber.
4	Press [YES] key to measure and store loss characteristics of measurement system.

Note:

The measuring conditions are set automatically as follows:

Log scale:	5 dB/div
Reference level:	-40 dBm
Resolution:	(Optimum value depending on span)
Averaging:	10 times
Data memory:	2
High sensitivity:	ON

The next message is displayed during measurement:

SHORT FIBER measuring

When measurement ends, the next message and soft key are displayed:

Connect FIBER TO BE MEASURED ok?
[YES] [END]

5	Change short fiber to fiber to be measured.
6	Press [YES] key to measure and store the overall loss characteristics of the measurement system with the fiber to be measured.

(Cont.)

Step	Procedure
6 (cont.)	Note: The measuring condition is the same as that of step 4 except that data memory is changed from 2 to 3. The next message is displayed during measurement: FIBER measuring When measurement ends, the graph screen is changed to LOSS mode and the loss-wavelength characteristics of the fiber to be measured are displayed. The next message and soft key are displayed: FIBER measure end [NEXT] [END]
7	Press desired soft key. Note: Press the [NEXT] key to measure another fiber. Press the [END] key to end loss measurement.

(e) Transmission measurement procedure

Optical filter transmission characteristics measurement is described in this paragraph.

This procedure is continued from paragraph (a).

Step	Procedure
1	Press [F4] soft key. The following message and soft keys are displayed. WAVE LENGTH ok? [YES] [RECALL] [END]
2	Press desired soft key. Note: Press [YES] key when wavelength range is OK. Press [RECALL] key to recall the wavelength range from data memory 3 which stores the wavelength data of the previous transmission measurement. For new wavelength range, set the wavelength range (paragraph 3.7.5 (1)) and press [YES] key. Press [END] key to end transmission measurement. Example: When [YES] or [RECALL] key is pressed, the next message and soft keys are displayed to set up measurement system for measuring the transmission characteristics of the measurement system.

(Cont.)

Step	Procedure

2
(cont.)

Set DEVICES without FILTER ok?

[YES] [END]

3 Set up the measurement system without optical filter (device under test) in the MA919B, as shown below.

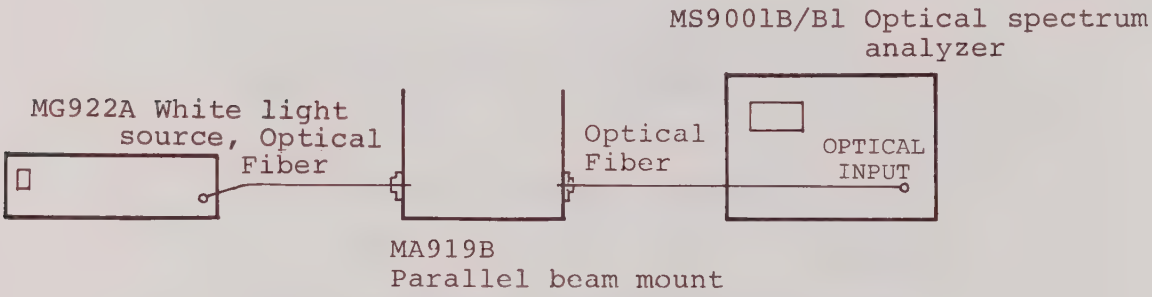


Fig. 3-7 Transmission Characteristics Measurement Setup

4 Press [YES] key to measure and store transmission characteristics of measurement system.

Note:

The measurement conditions are set automatically as follows:

Log scale:	5 dB/div
Reference level:	-40 dBm
Resolution:	(Optinum value depending on span)

(Cont.)

Step	Procedure
4 (cont.)	Averaging: 10 times Data memory: 2 High sensitivity: ON

The next message is displayed during measurement:

Without FILTER measuring

When measurement ends, the next message and soft keys are displayed:

Set FILTER ok?

[YES] [END]

5 Set optical filter (device under test) in the MA919B.

6 Press [YES] key to measure and store the overall transmission characteristics (measurement system + optical filter).

Note:

The measurement conditions are the same as that of step 4 except that data memory is changed from 2 to 3.

(Cont.)

Step	Procedure
6 (cont.)	The next message is displayed during measurement: FILTER measuring When measurement ends, the graph screen is changed to transmission mode and the transmission-wavelength characteristics of the filter are displayed. The vertical axis of the graph is in % units. The next message and soft keys are displayed: FILTER measure end [NEXT] [END]
7	Press desired soft key. Note: Press the [NEXT] key to measure another filter. Press the [END] key to end transmission measurement.

3.7.5 Manual measurement condition setting

(1) Wavelength setting

- Wavelength is set using the [START] - [STOP] keys and the [CENTER] - [SPAN] keys.

The measurement waveform on the screen and the wavelength marker can also be used for wavelength setting. To set the peak wavelength of the measurement waveform to the center wavelength, press the [PEAK → CENTER] key. To set the wavelength of the main marker to the center wavelength, press the [MARKER → CENTER] key. To set the width between wavelength markers 1 and 2 to span (sweep width), press the [ΔW-SPAN] key.

The minimum wavelength setting unit is 0.0001 μm.

(a) Wavelength setting using [START] and [STOP] keys

After the [START] or [STOP] key is pressed and data is input, the start wavelength on the bottom left side of the CRT is set; the stop wavelength on the bottom right side is set.

The start wavelength can be set in units of 0.0001 μm. The stop wavelength is calculated (start wavelength + sweep width), and displayed.

(Cont.)

Step	Procedure
6 (cont.)	The next message is displayed during measurement: FILTER measuring When measurement ends, the graph screen is changed to transmission mode and the transmission-wavelength characteristics of the filter are displayed. The vertical axis of the graph is in % units. The next message and soft keys are displayed: FILTER measure end [NEXT] [END]
7	Press desired soft key. Note: Press the [NEXT] key to measure another filter. Press the [END] key to end transmission measurement.

3.7.5 Manual measurement condition setting

(1) Wavelength setting

Wavelength is set using the [START] - [STOP] keys and the [CENTER] - [SPAN] keys.

The measurement waveform on the screen and the wavelength marker can also be used for wavelength setting. To set the peak wavelength of the measurement waveform to the center wavelength, press the [PEAK → CENTER] key. To set the wavelength of the main marker to the center wavelength, press the [MARKER → CENTER] key. To set the width between wavelength markers 1 and 2 to span (sweep width), press the [ΔW-SPAN] key.

The minimum wavelength setting unit is 0.0001 μm.

(a) Wavelength setting using [START] and [STOP] keys

After the [START] or [STOP] key is pressed and data is input, the start wavelength on the bottom left side of the CRT is set; the stop wavelength on the bottom right side is set.

The start wavelength can be set in units of 0.0001 μm. The stop wavelength is calculated (start wavelength + sweep width), and displayed.

Procedure 1

Step	Procedure
1	Press [START] key.
2	Set start wavelength by turning rotary knob.
3	Press [STOP] key.
4	Set stop wavelength (sweep width) by turning rotary knob.

Procedure 2

Step	Procedure
1	Press [START] key.
2	Press [0], [.], [6], [2], [1], [0], [μ] keys in this sequence.
3	Press [STOP] key.
4	Set stop wavelength (sweep width) by turning rotary knob.

Procedure 3

Step	Procedure
1	Press [START] key.
2	Set start wavelength by pressing [≪] and [≫] keys.
3	Press [STOP] key.
4	Set stop wavelength (sweep width) by pressing [≪] and [≫] keys.

Notes:

1. The stop wavelength cannot be set with numeric keys.
2. The step value depends on the sweep width when the start wavelength is set by rotary knob.
3. For procedures 1 and 2 above, setting with [≪] and [≫] keys can be made instead of setting with rotary knob.
4. In the event of an numeric input error, to return to the previous status, press the [BACK SPACE] key.

(b) Wavelength setting using [CENTER] and [SPAN] keys

Pressing the [CENTER] and [SPAN] keys, sets the center wavelength of the CRT and the sweep width (span). The center wavelength can be set in 0.0001 μm units. The sweep width (span) is changeable in discrete steps of 1, 2, and 5 (paragraph 3.5.3).

Procedure 1:

Step	Procedure
1	Press [CENTER] key.
2	Set center wavelength by turning rotary knob.
3	Press [SPAN] key.
4	Set span (sweep width) by turning rotary knob.

Procedure 2:

Step	Procedure
1	Press [CENTER] key.
2	Press [0], [.], [8], [5], [8], [8], [μ] keys in this sequence.
3	Press [SPAN] key.
4	Set span (sweep width) by turning rotary knob.

Procedure 3:

Step	Procedure
1	Press [CENTER] key.
2	Set center wavelength by pressing [≪] and [≫] keys.
3	Press [SPAN] key.
4	Set span (sweep width) by pressing the [≪] and [≫] keys.

Notes:

1. The span (sweep width) cannot be set with the numeric keys.
2. The step value depends on the sweep width when the center wavelength is set with the rotary knob.
3. For procedures 1 and 2 above, setting with [≪] and [≫] keys can also be made instead of setting with the rotary knob.

(c) Wavelength setting using [PEAK → CENTER] key

Pressing the [PEAK → CENTER] key sets the peak wavelength (wavelength at maximum level) of the measurement waveform on the CRT to the center wavelength position.

Procedure:

Step	Procedure
1	Press [PEAK → CENTER] key.
2	Perform sweep by pressing [SINGLE] or [REPEAT] key.

Note:

At operation of the [PEAK → CENTER] key, a waveform that is outside the measurement range may not be displayed.

To display this waveform, the step 2 is performed.

If a waveform is not displayed on the CRT and the [PEAK → CENTER] key is pressed, the message "peak not found" is displayed at the bottom left of the CRT.

(d) Wavelength setting using [MARKER → CENTER] key. The wavelength of the main marker can be set to the center wavelength by pressing the [MARKER → CENTER] key.

Procedure:

Step	Procedure
1	Display main marker by pressing [MAIN] key.
2	Shift main marker to desired wavelength by using rotary knob or [≪]/[≫] keys.

(Cont.)

Step	Procedure
3	Press [MARKER → CENTER] key to set the main marker wavelength to center wavelength.
4	Perform sweep by pressing [SINGLE] or [REPEAT] key.

Note:

Through operation of the [MARKER → CENTER] key, a waveform that is outside the measurement wavelength range may not be displayed. To display this waveform, the step 4 is performed.

If a waveform is not displayed on the CRT and the [MAIN] key is pressed, the message "operation error" is displayed at the bottom left of the CRT.

(e) Wavelength setting using [ΔW → SPAN] key

Pressing the [ΔW → SPAN] key makes the center between wavelength markers 1 and 2 becomes the center wavelength. The sweep width is set to the nearest sweep width that exceeds the width between the two markers.

Procedure:

Step	Procedure
1	Set wavelength marker 1 by pressing [WAVELENGTH 1] key.
2	Shift wavelength marker 1 to desired wavelength by turning rotary knob or pressing [≪] and [≫] keys.
3	Set wavelength marker 2 by pressing [WAVELENGTH 2] key.

(Cont.)

Step	Procedure
4	Shift wavelength marker 2 to desired wavelength by turning rotary knob or pressing [《] and [》] keys.
5	Press [ΔW → SPAN] key.

(2) Level scale setting

The [LOG]/[REFERENCE LEVEL] keys or the [LINEAR]/[EXPAND] keys set the scale.

The [PEAK → LEVEL] key sets the linear range to the peak of the measurement value.

The [LINEAR] key is used to set the level range at the linear display in steps of 1, 2, 5, and 10.

The [EXPAND] key expands the waveform in the same linear level range.

The [LOG] key sets the measurement scale in the log display.

The scale is divided into 0.2, 0.5, 1, 2, 5, and 10 dB/div.

The [REFERENCE LEVEL] key sets the level of the top horizontal line on the log display.

(a) Level scale setting using [LINEAR] and [EXPAND] keys

Procedure 1:

Step	Procedure
1	Press [LINEAR] or [EXPAND] key.
2	Turn rotary knob to set linear level range.

Procedure 2:

Step	Procedure
1	Press [LINEAR] or [EXPAND] key.
2	Press [⩓] or [⩔] key to set linear level range at linear mode.
	Note:
	The [FAST] key is invalid.

Procedure 3:

Step	Procedure
1	Press [LINEAR] key.
2	Press numeric keys (for example, 500, 200, 100, 50, 20, 10, 5, 2, 1) to set linear level range.
3	Press unit key [m], [μ], or [n].
	Notes:
	1. When a number outside the linear level range is input, the nearest range over that number is set. For example, [LINEAR], [4], [0], [μ] keys entry sets the 50 μW linear range.
	2. Linear level scale value setting using numeric keys
	To set units of mW, μW, or nW, press the [m], [μ], or [n/ENTER] key, respectively. There is no key for pW.

Note:

The [EXPAND] key is invalid in the log mode.

(b) Level scale setting using [LOG] and [REFERENCE LEVEL] keys

Note:

The [REFERENCE LEVEL] key is valid in the log mode only.

Procedure 1:

Step	Procedure
1	Press [LOG] or [REFERENCE LEVEL] key.
2	Turn rotary knob to set scale.

Procedure 2:

Step	Procedure
1	Press [LOG] or [REFERENCE LEVEL] key.
2	Press [⩓] or [⩔] key.
	Note: The [FAST] key is invalid.

Procedure 3:

Step	Procedure
1	Press [REFERENCE LEVEL] key.
2	Press [+/-] key to select + or - in accordance with sign of reference level.

(Cont.)

Step	Procedure
3	Press numeric keys (for example, [1][0], [5][3], or [2][7] to set absolute value of reference level.
4	Press [ENTER] key.
5	Example: Press [LOG], [REFERENCE LEVEL], [+/-], [1], [7], [ENTER] in this sequence to set reference level to -17 dBm.

Notes:

1. The [REFERENCE LEVEL] key is invalid in the LINEAR mode.
2. In the LOG mode, the dB/div value cannot be set by the numeric keys.

(c) Level scale setting using [PEAK→LEVEL] key

Pressing the [PEAK→LEVEL] key, changes the reference level to suit with the maximum level of the measurement value.

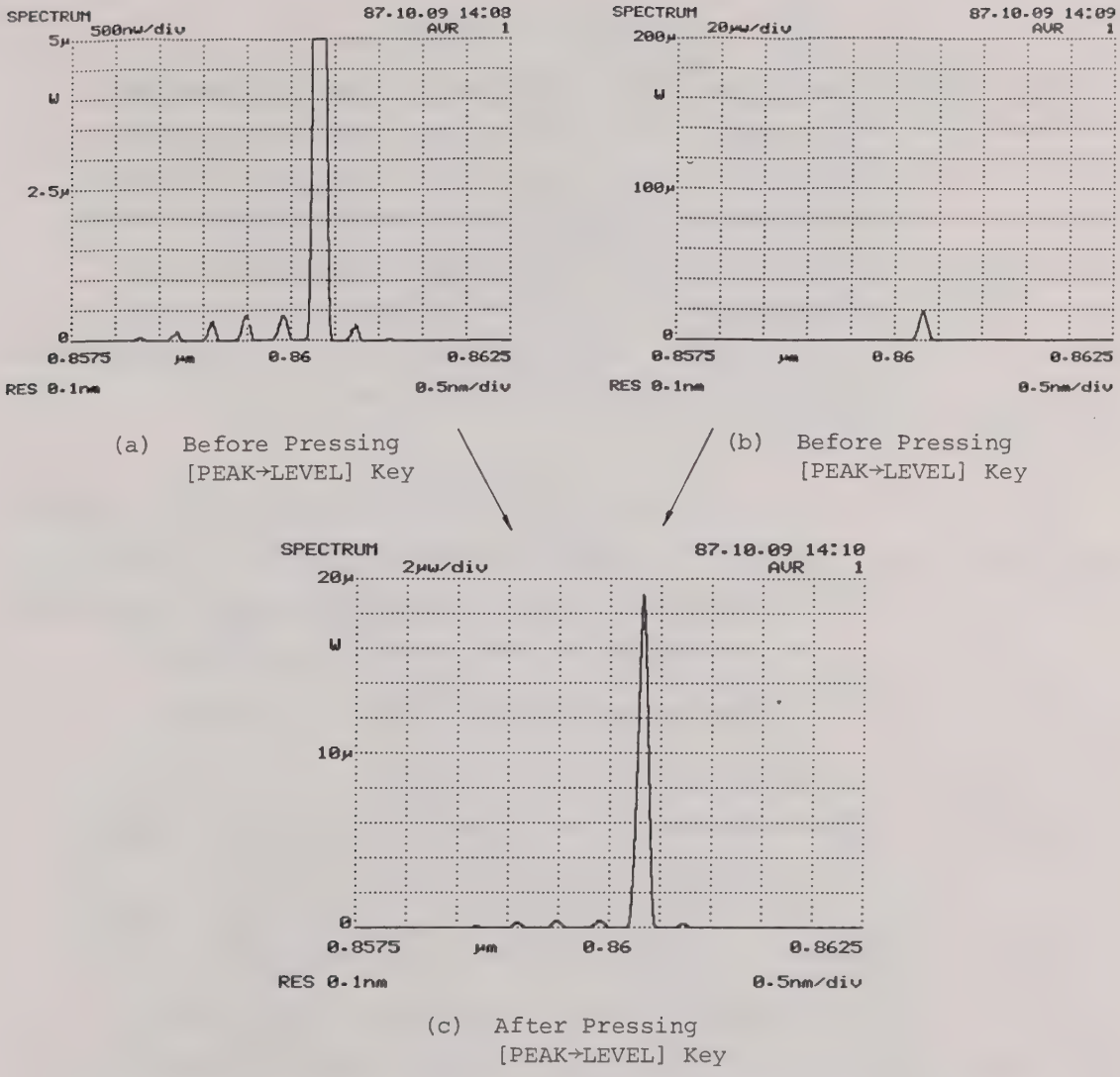


Fig. 3-8 Changing Display at [PEAK→LEVEL] Key Operation

When the current level range and the maximum value of the measurement level are very different, the waveform that follows pressing of the [PEAK→LEVEL] key will be clipped or noisy.

In this case, repeat between measurement and use of this key. When the repeating operation occurs at the repeated sweep mode, the optimum measurement level range can be quickly achieved.

(d) High sensitivity setting

Press the [HIGH SENSITIVITY] key to measure low-level input light with greater accuracy. When this key is set to ON, the input light is chopped by a chopper and the dc offset (dark current) of the light-receiving element is subtracted for more accurate optical power measurement. The LED above this key remains lit, while the HIGH SENSITIVITY mode is on.

Notes:

1. To reduce the sweep time, press the [FAST] key to set the sweep time to FAST mode.
2. The input light measuring range also varies according to the setting conditions.

   See paragraph (e) below for details.

(e) Optimum dynamic range setting

The MS9001B/B1 has several linear amplifiers. The amplifier range is either fixed or automatically changed according to the level scale, and the dynamic range changes.

The dynamic range also changes with the high-sensitivity and sweep-time settings.

The following condition-setting functions affect the dynamic range.

. Level scale	LOG	Auto range (Note 1)
	LINEAR ...	Fixed range
. High sensitivity	ON	Chopping
	OFF	No chopping

. Sweep time NORMAL
FAST ..... Measurement points reduced by half (Note 2)

Notes:

1. The fixed range mode is used for case [G] as listed in Table 3-5, even when the log scale is set.
2. The number of measurement points is halved only for a sweep width of 2 nm or less in FAST mode.

Table 3-5 lists the combinations of setting conditions that affect the dynamic range.

Table 3-5 Combinations of Setting Conditions Affecting Dynamic Range

Case	Level scale	High sensitivity	Sweep time	Measuring range
A	LINEAR	ON	FAST	$\geqq$-70 dBm
B	LINEAR	ON	NORMAL	$\geqq$-70 dBm
C	LINEAR	OFF	FAST	$\geqq$-60 dBm
D	LINEAR	OFF	NORMAL	$\geqq$-60 dBm
E	LOG	ON	FAST	-60 to +10 dBm, DFB laser
F	LOG	ON	NORMAL	-70 to +10 dBm, DFB laser, fiber loss
G	LOG	OFF	FAST	Approx. 20 dB dynamic range
H	LOG	OFF	NORMAL	-40 to +10 dBm

The optimum input level range for the cases listed in Table 3-5 are:

LINEAR mode

1. Cases (A) and (B) are used for accurate measurements of optical input levels down to -60 to -70 dBm (1 nW or less), although the sweep speed is reduced.

2. Cases (C) and (D) are used for linear scale measurements. Case (C) is used for high-speed sweep measurements (only when the sweep width (span) is 2 nm or less).

LOG Mode

1. Case (E) is used for measurements over a wide dynamic range of -60 to +10 dBm. This is suitable for DFB laser measurement in the third mode at a sweep time faster than that for case (F).

2. Case (F) is used for measurements over a wide dynamic range of -70 to +10 dBm (including the lowest measurable level). This is suitable for measuring fiber loss.

3. Case (G) is used when a dynamic range of approx. 20 dB is sufficient.

   In this case, a sweep can be made quickly.

4. Case (H) is used for measurements in a range from -40 to +10 dBm.

Note:

If the sweep time is set in the FAST mode with a sweep width (span) of 2 nm or less, the number of measurement points is halved.

(3) Resolution setting

The wavelength resolution is set by pressing the [RESOLUTION] key.

Resolution is set to 0.1, 0.2, 0.5, 1, 2, or 5 nm by using the stepping motor to shift the slit in the optical mechanism section.

The following is displayed on the message line:

RESOLUTION X nm ↑, ↓,
[ROTARY] or [ENTRY] key

Input by using the [⩓] and [⩔] keys, rotary knob, and numeric keys can now be carried out.

(a) Resolution setting by step keys

The resolution is set in the following sequence when the [⩓] key is pressed:

5 → 2 → 1 → 0.5 → 0.2 → 0.1 nm

When the [⩔] key is pressed, the sequence is reversed.

(b) Resolution setting by rotary knob

Setting is in the following sequence when the knob is turned clockwise:

5 → 2 → 1 → 0.5 → 0.2 → 0.1 nm

When the knob is turned counterclockwise, the setting is reversed.

(c) Resolution setting by numeric keys

Press the keys [0], [.], [5], [n ENTER] in this sequence to set 0.5 nm resolution.

Note:

When the resolution is set by numeric keys, if a numeric other than 0.1, 0.2, 0.5, 1, 2, or 5 is input, the resolution is set to the nearest value above that value.

For example, the resolution is set to 0.5 nm even if 0.3 nm is input. Moreover, when a value larger than 5 is input, the resolution is set to 5 nm.

(d) Relationship between resolution and fiber core diameter

As mentioned in the principles of operation (Section 5), the setting of resolution is performed by the stepping motor moving the slit. Resolution depends on the core diameter of the optical fiber of the incident light in addition to the slit width. Also, because reverse dispersion depends upon the wavelength, the resolution will also vary with the measured wavelength. The slit width is varied according to the measuring range.

The setting of the resolution is performed under the assumption that the diameter of the fiber is sufficiently small. As a result, the actual resolution obtained and the indicated resolution may differ depending upon the diameter of the fiber. The following is a rough guide.

Fiber			Suitable Resolution
1.3 μm	SM	(Core diameter 10 μm)	0.1 nm
1.3 μm	GI	(Core diameter 50 μm)	0.2 nm
0.85 μm	GI	(Core diameter 50 μm)	0.2 nm
0.85 μm	Steps index	(Core diameter 500 μm)	2 nm

Note:

If an improper resolution is set, the message "RES uncal" is displayed at the bottom left of the CRT.

(4) Average time setting

Setting of the average time is carried out after the [AVERAGE TIME] key is pressed. An average time of 1 to 1000 times is set. By using the numeric keys, a setting of 1 to 1000 in single steps is set. By using the rotary knob or the [≪] and [≫] keys, 1, 2, 5, 10, 20, 50, 100, 200, 500, or 1000 is set.

Procedure 1:

Step	Procedure
1	Press [AVERAGE TIME] key.
2	Press [2], [0], [0], and [ENTER] keys in this sequence to set 200 times, for example.

Procedure 2:

Step	Procedure
1	Press [AVERAGE TIME] key.
2	Set number of times by turning rotary knob.

Procedure 3:

Step	Procedure
1	Press [AVERAGE TIME] key.
2	Set number of times by pressing [≪] and [≫] keys.

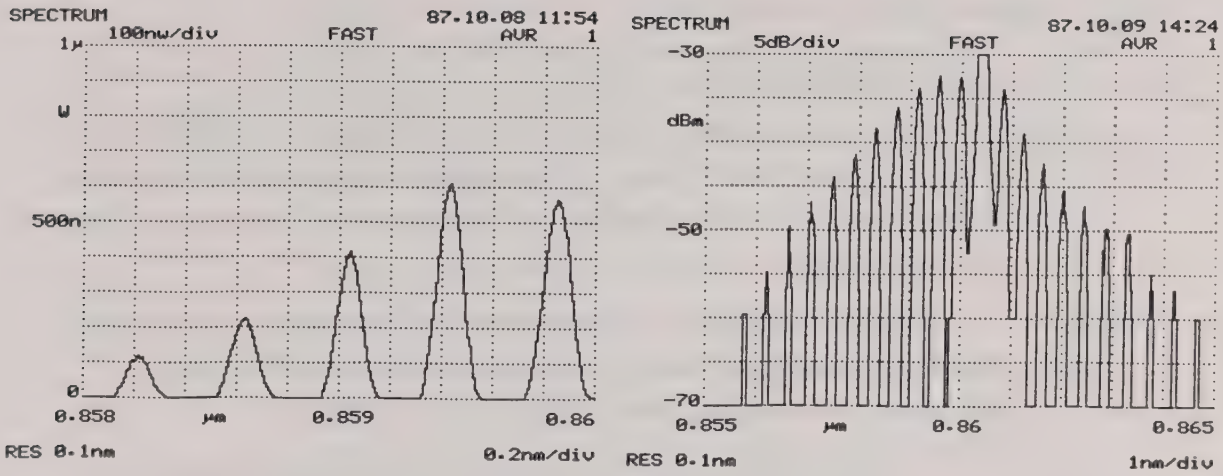
(5) Sweep time setting

Press the [SWEEP TIME] key to change the sweep time setting.

The MS9001B/B1 has two sweep time modes: NORMAL and FAST. To reduce the sweep time, use the FAST mode. When using the FAST mode, "FAST" is displayed at the upper-left of the CRT.

Notes:

1. At a sweep width (span) of 2 nm or less in the FAST mode, the number of measurement points is halved. When HIGH SENSITIVITY is switched OFF for the log scale, the dynamic range is 20 dB.
2. The other settings that automatically change the sweep time are: level scale (linear or log); high sensitivity (ON or OFF); sweep width; and average time. See paragraph 4.3 for details of the measuring time.



(a) Number of Measurement Points Halved

(b) 20 dB Dynamic Range

Fig. 3-9 Fast Mode

(6) Sweep mode setting

This mode sets, starts, and stops the sweep during measurement. The sweep keys have SINGLE, REPEAT, MARKER/FULL, and STOP modes.

Press the [SINGLE] key for only one sweep. At this time, the sweep always returns to the left edge of the wavelength range and starts from this point.

Press the [REPEAT] key for repeated sweeps.

When the [REPEAT] key is pressed once while sweep is at a standstill, sweep is made continually from the point where it was stopped. When the [REPEAT] key is pressed during a repeat sweep, sweep is made from the left edge of the screen.

Press the [MARKER/FULL] key for limited sweep between the two wavelength markers. The sweep mode becomes full sweep when the wavelength marker is not displayed.

Press the [STOP] key to stop sweep.

3.7.6 Manual display setting

(1) Trace mode setting

The trace mode is set by pressing the [SPECTRUM], [TRANS], or [LOSS] key. The lamp of the selected mode lights and the set mode is displayed at the upper left of the CRT.

In the trans or loss mode at log mode, the result is displayed in dB by calculating the difference between data memories 2 (REF) and 3 (MEA).

In the trans mode at linear mode, the result is displayed in percentage units by calculating the MEA/REF division.

(a) Spectrum mode

The spectrum mode is set by pressing the [SPECTRUM] key. (The initial setting after power on is the spectrum mode.) This mode is normally used for measuring LDs, LEDs, etc.

(b) Trans mode

The trans mode is set by pressing the [TRANS] key once. Pressing it again after data memories setting of 3 (MEA) and 2 (REF) (paragraph (2)), subtracts data in the data memories and displays the results of the subtraction (MEA [data memory 3] - REF [data memory 2]).

In log mode, it is possible to execute subtraction between stored data in REF (data memory 2) and the data being measuring in MEA (data memory 3) as follows:

After data memory setting of 2 (REF) (paragraph (2)), Select data memory 3 by using the [DATA MEMORY] key and start measurement of DUT. At the same time, the subtraction operation between the measurement data (MEA [data memory 3], and stored data (REF [data memory 2]) is executed and the result (MEA-REF) is displayed.

In the linear mode, MEA/REF division is carried out and the result is displayed in percentage units. This is used to measure and display the transmission ratio of optical fibers etc.

(c) Loss mode

The loss mode is set by pressing the [LOSS] key in the log mode. (REF [data memory 2] - MEA [data memory 3]) is displayed. This is only possible in the log mode.

In log mode measurement, it is also possible to subtract between stored data and the data being measured in the same way as in the trans mode.

(2) Data memory setting

To store the data in the memory, press the appropriate [DATA MEMORY] key (the lamp over the key lights), and press the sweep mode [SINGLE] or [REPEAT] key.

To recall data from the memory, press the [RECALL] key and then press the [DATA MEMORY] key for the memory from which data is to be recalled (the lamp over the key lights).

There are three memories. Subtraction can be performed with data memory 2 and 3 keys (paragraph (1)).

(3) Data recall and clear

The [GRAPH DISPLAY] and [GRAPH & MARKER CLEAR] keys are used to recall and clear data as follows:

Step	Procedure
1	Press [GRAPH DISPLAY] key to display measured graph.
2	Press [GRAPH & MARKER CLEAR] and [GRAPH DISPLAY] keys in this sequence to clear marker only on graph/marker displayed CRT screen. A graph and a marker are displayed; to clear the marker, press the [GRAPH & MARKER CLEAR] key once and then press the [GRAPH DISPLAY] key. Press the [GRAPH DISPLAY] key when the data memory is changed and the graph data in the memory is displayed.
3	Change data memory and press [GRAPH DISPLAY] key to display graph of changed data memory. Note: If the measurement conditions (wavelength and resolution) of the selected data memory do not coincide with that of the CRT screen, the next message is displayed and a graph is not displayed. w.1. changed, push recall data n
4	Press [GRAPH & MARKER CLEAR] key to clear. When a marker is displayed, only the marker is cleared. When a marker is not displayed, the graph is cleared. Therefore, when a graph and a marker are displayed, the first press of this key clears the marker, and the second press clears the graph.

(4) Marker setting

There are three types of markers; Main (one point, level and wavelength are indicated.), Level (one level), and Wavelength (two wavelengths) markers.

(a) Main marker

Press the [MAIN] key to display one main marker on the graph by the cursor (▽).

The main marker is set and moved on the graph by using the rotary knob, [≪] and [≫] keys, and the numeric keys. The level and wavelength values of the main marker are also displayed on the CRT.

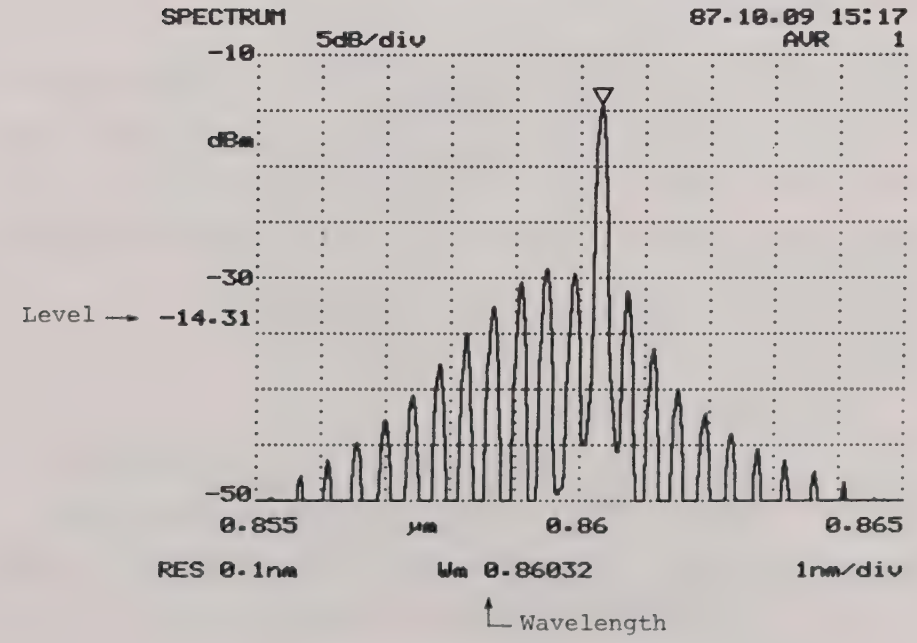


Fig. 3-10 Main Marker (▽)

Procedure 1:

Step	Procedure
1	Press [MAIN] key to set main marker (▽).
2	Turn rotary knob to set main marker at desired point.

Procedure 2:

Step	Procedure
1	Press [MAIN] key to set main marker (▽).
2	Press [0], [.], [8], [4], [5], and [μ] keys in this sequence to set main marker at 0.845 μm, for example.

Procedure 3:

Step	Procedure
1	Press [MAIN] key to set main marker (▽).
2	Press [≪] and [≫] keys to set main marker at desired point.

Peak search function:

Press the [PEAK SEARCH] key to set main marker (▽) at the maximum level measured point. The level and wavelength of the peak point is displayed.

Half center function:

Press the [HALF CENTER] key to set main marker ( ) at the center wavelength position between the upper and lower wavelengths of the half peak level with the peak level.

Zero marker function:

Press the [ZERO ON/OFF] key to set zero marker [reference marker, with a cursor (+)] at the main marker position.

The zero marker (▼) is fixed and only the main marker (▽) can be shifted.

The level ratio (in linear scale) or the level difference (in log scale) between the main and zero markers is displayed at the left of the scale; the wavelength difference (Wn) is displayed at the bottom center.

Pressing the [ZERO ON/OFF], [MAIN], [PEAK SEARCH], or [HALF CENTER] key leaves the zero marker mode.

(b) Level marker

Level markers 1 and 2 are displayed as horizontal alternate-long-and-short-dash-line (——·———·——) and alternate-long-and-two-short-dashes-line (——··———··——) on the screen, and the level value is also displayed.
(Markers 1 and 2 can be switched by pressing the [LEVEL] key again.)
Note that for linear scaling in the TRANS mode, no level marker can be set.
Level marker setting procedures

Procedure	Step	Operation
a	1	Press the [LEVEL] key.
	2	Turn the rotary knob to set the level marker.
b	1	Press the [LEVEL] key.
	2	Press the keys in the following order: [1] [2] [3] [m] [μ] [n]
c	1	Press the [LEVEL] key.
		Set the level marker by pressing the [∧] or [∨] keys.

(c) Wavelength marker

Press the [WAVELENGTH 1] and [WAVELENGTH 2] keys to display two wavelength markers on the CRT as two vertical broken line (—— – —— – ——). The two wavelength values of the two wavelength markers are also displayed on the bottom of the CRT. The wavelength markers are set and moved horizontally by using the rotary knob, [≪] and [≫] keys, and numeric keys. The wavelength markers cannot cross each other;

Start wavelength < Wavelength marker 1 < Wavelength marker 2 < Stop wavelength.

Procedure 1:

Step	Procedure
1	Press [WAVELENGTH 1] (or [WAVELENGTH 2]) key to set wavelength marker 1 (or 2).
2	Turn rotary knob to set wavelength marker 1 (or 2) at desired wavelength.

Procedure 2:

Step	Procedure
1	Press [WAVELENGTH 1] (or [WAVELENGTH 2]) key to set wavelength marker 1 (or 2).
2	Press [0], [.], [8], [5], [6], and [μ] keys in this sequence to set wavelength marker 1 (or 2) at 0.856 μm, for example.

Procedure 3:

Step	Procedure
1	Press [WAVELENGTH 1] (or [WAVELENGTH 2]) key to set wavelength marker 1 (or 2).
2	Press [≪] and [≫] keys to set wavelength marker 1 (or 2) at desired wavelength.

Half-width function:

Press the [HALF WIDTH] key to set level marker on the 1/2 peak and the wavelength markers (2 and 1) at the upper and lower positions of the half peak level.

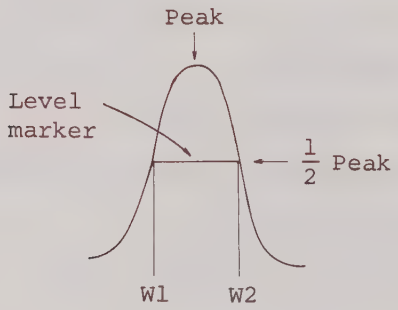


Fig. 3-11 Markers Setting at Half-width Function

(d) Moving marker with [FAST] and [COARSE] keys

When moving the level marker, wavelength marker, main marker, or zero marker by rotary knob, press the [COARSE] key (ON) to increase the marker movement per click.

If the [FAST] key is pressed while pressing the [≪] or [≫] key, the marker displacement is increased. When the [COARSE] key is held down, press only the [≪] or [≫] key to increase marker movement.

Because this function enables a marker to be positioned roughly at the waveform destination, moving the marker does not require a long time.

If the marker is positioned too close to the waveform destination, fine-adjust its position without using the [COARSE] or [FAST] key.

3.7.7 Other functions setting

(1) REMOTE/LOCAL setting

There is a GP-IB control mode (REMOTE control) and a front panel keys control mode (LOCAL control).

The mode can be switched to LOCAL control by pressing the [LOCAL] key in the remote mode.

(2) Level correction

The MS9001B/B1 guarantees an absolute level accuracy of less than ±2 dB. Greater level accuracy can be obtained by using this method.

The MS9001B/B1 input circuit is designed for SM fiber with an NA of 0.09. When the fiber NA is more than 0.09 (for example, GI fiber), the input level cannot be measured correctly. In this case, perform the following procedure.

(a) Setup

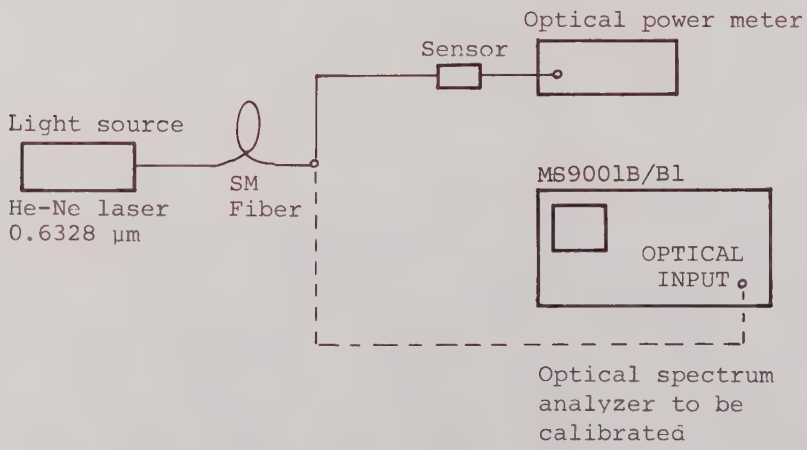


Fig. 3-12 Level Correction Setup

(b) Equipment required for correction

1. Light source: Stable gas laser, LD, etc. with a narrow spectral width

2. Optical power meter: Instrument capable of absolute power measurement or instrument calibrated accordingly.

3. SM fiber

(c) Procedure

MS9001B/B1 measurement conditions are: Resolution 5 nm, and optical input level $\geq$ -30 dBm (1 µW).

Use the [CAL] key and level marker to correct the MS9001B/B1 level in the LINEAR scale mode as shown below.

Step	Procedure
1	Measure the optical power with an optical power meter (for example, 40 µW).
2	Measure the same optical power with the MS9001B/B1 as follows: a. Set to the linear scale. b. Set the resolution to 5 nm. c. Display the waveform on the CRT. d. Set the level marker to the peak of the waveform as follows: Press the [LEVEL] key to display the level marker on the CRT. Turn the rotary knob and move the level marker to the peak. This marker level is the measured level (for example, 38 µW).

(Cont.)

Step	Procedure
3	Correct the above level marker value to the value (40 µW) measured with the power meter as follows: Press the [CAL] [4] [0] [µ] keys in this sequence. Three seconds later, the corrected waveform appears on the CRT. Notes: 1. In the MS9001B/B1, the level correction coefficient K is calculated automatically. K = Correction value/MS9001B/B1 measured value = Power meter measured value/level marker value = 40/38 = 1.05 2. The default value of K is 1.00. Back-up storage of the K value is not available. 3. The value of K must be within the $0.1 < K < 10.0$ range.

(3) Setting to initial screen after power on

Pressing the [INITIAL] key sets the initial screen after power on at any time.

(4) Storing and recalling measurement conditions

The measurement conditions can be stored to internal memories. The back-up function prevents loss of the stored measurement conditions even when the power is turned off.

There are 10 memories numbered 0 to 9.

(a) Storing measurement conditions

When the [SAVE] and [3] keys are pressed in this sequence, the current measurement conditions are stored to memory 3. The same procedure but using the other numeric keys stores measurement conditions to the other memories.

(b) Recalling measurement conditions

When the [RECALL] [3] keys are pressed in this sequence, the measurement conditions stored in memory 3 are recalled and set. The same procedure can be used to recall measurement conditions from the other memories.

(5) Advanced functions

The following functions can be set or executed as advanced functions by using the soft keys (F1 to F5).

. TITLE

This function displays characters, numbers, and symbols in the graph field of the CRT screen.

. TIME

This function sets the year, month, day, hour, and minute for display at the upper-right part of the CRT.

. ANALYSIS

This function analyzes the LD spectrum and displays its center wavelength and spectrum width.

. GP-IB address

This function displays the address set by the GP-IB address switches.

. PLOTTER

Copies the CRT display at the digital plotter.

Refer to paragraph 4.7.9.

Activation

Press the [BEGIN] key to set the soft keys (F1 to F5) as ADVANCE function keys and to display the functions at the bottom of the CRT corresponding to each key position.

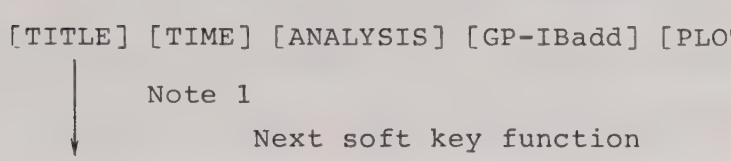
Deactivation

Press the [RETURN] key to deactivate the functions.

Note

When the ADVANCED function is activated, except for TITLE, each key on the right side of the panel is inoperative. This status is released by the [RETURN] key.

Soft key functions (Example)



Note 1:

This indicates that the [TITLE] soft key is to be pressed.

Outline of soft key functions

[TITLE]

[INS/RPL]	Switches cursor display
	■ Adds or replaces character
	◀ Inserts character
[DEL]	Deletes character at cursor position and shifts subsequent string one character to left
[DEL LINE]	Erases line where cursor located
[CLEAR]	Erases all key input characters
[END]	Terminates title input function
[SCROLL]	Selects title character type among capital, small, and symbol.
(Capital)	specifies upper-case alphabetic and Greek characters
(Small)	specifies lower-case alphabetic characters
(Symbol)	specifies symbols

The title input range is the graph display area (inside grid) and occupies the upper half. If the title is input in the lower half (conversational message) some parts (TIME message) are cleared. The upper-right disappears when an analysis is performed. The output range to the external plotter (paragraph 4.7.9) is at the upper-left and includes 11 characters horizontally and 10 lines vertically. It is recommended that characters are written in this range.

[TIME]

Enter two digits each for the year, month, day, hour, and minute in successive order and then press the [ENTER] key.

Example:

To set 14:07 on February 5, 1988, press [TIME], [8],[8],[0],[2],[0],[5],[1],[4], [0],[7], and [ENTER].

Use the 24-hour clock to set and display the time.

[END]

Terminates TIME input

[ANALYSIS]

Menu 1

F1 ... [RMS]	RMS method
F2 ... [ENVELOPE]	Envelope method
F3 ... [ndB LOSS]	ndB LOSS method
F4 ... [CLEAR]	Deactivates analysis function
F5 ... [END]	Terminates analysis selection

[SCROLL] Switches between soft key menus 1 and 2

Menu 2

F1 ... [S.LEVEL] Sets assumed spectrum level

F2 ... [kσ] Sets multiple of σ for the RMS method

The assumed spectrum level for the RMS method and the value of n for the ndB LOSS method are input with the numeric keys.

Example:

To set the assumed spectrum level to 1/100 (20 dB) or more of the peak:

Press [S.LEVEL],[0],[.],[0],[1], and [ENTER] on the linear scale. The value of n is set to 20 (dB) at the same time. The input value range on the linear scale is from 0.001 to 0.999.

Press [S.LEVEL],[2],[0], and [ENTER] on the log scale. The linear level ratio is set to 1/100 at the same time. The input value range on the log scale is an integer from 1 to 25, 27, and 30.

The same value is used for the RMS and ndB LOSS method and is changed concurrently.

To use a different value for analysis, set it each time and analyze by pressing the [RMS] or [ndB LOSS] key.

According to the RMS method, the spectrum width calclulation value can be selected from σ, 2σ, 2.35σ, and 3σ.

Example:

To display 2σ, press [kσ], [2σ], and [END].

Calculation is executed according to the RMS method when the span is set to 100n or less.

(6) Wavelength calibration

Wavelength is calibrated by using the two rotary switches on the rear panel.

The entire wavelength range can be shifted by -4.9 to +4.9 nm in 0.1 nm steps with the switches.

The calibrator procedure is described below:

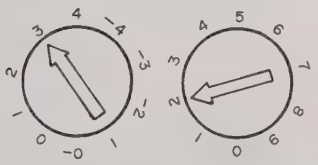
Step	Procedure
1	Use a stable light source of known wavelength (for example, He-Ne laser of 0.6328 μm wavelength).
2	Measure the light source wavelength with the MS9001B/B1 (for example, 0.6360 μm).
3	Calculate the error (for example, error = 0.6360 - 0.6328 μm = 0.0032 μm = 3.2 nm).
4	Set the power of the MS9001B/B1 to OFF.

(Cont.)

Step	Procedure
5	Set the wavelength calbiration switches to the error value.

WAVELENGTH CALIBRATION (n.m.)

Example:



X 1 X 0.1

3.7.8 Built-in printer setting

The MS9001B/B1 has a built-in printer, which records the measured results.

(1) Usage

Table 3-5 explains the printer key operation.

Table 3-5 Explanation of Printer Controls

Key	Explanation
PRINT	All information on the CRT is hard-copied by the built-in printer when this key is pressed. Measurement can be carried out during printer operation. Note: Press the [PRINT] key only after confirming that sweep has stopped. Copying cannot be performed during sweeps.
FEED	Press this key to feed paper in the built-in printer.
STOP	Copying is stopped by pressing the [STOP] key of the sweep mode. Copying starts from the beginning when the [PRINT] key is pressed following the stop.

(2) Replacing printer paper (Refer to Fig. 3-14.)

Replace printer paper as follows:

Step	Procedure
1	Open cover on top of mainframe.
2	Loosen stopper at each end of bar that secures paper roll in the center. Then remove the bar.

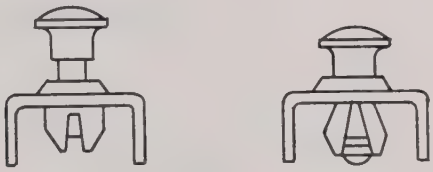


Fig. 3-13 Stopper

3	Replace paper.
4	Set bar in previous normal position and mount stoppers.
5	Pull lever forward (up) (Fig. 3-14).
6	Insert tip of paper (Fig. 3-14).
7	Turn white gear (Fig. 3-14).
8	Paper comes out (Fig. 3-14).
9	Press lever down (Fig. 3-14). (If it is still up, no printing occurs)

Notes:

1. To protect the printer head, paper should always be loaded. If paper is not loaded, the head will strike the rubber below and be damaged.

2. Printing paper can be obtained from ANRITSU.

   Recommended paper: TP50KS-F (Jyujo Seishi, Japan)

   F-200H (Mitsubishi Seishi, Japan)

   PS65B (Honshu Seishi, Japan)

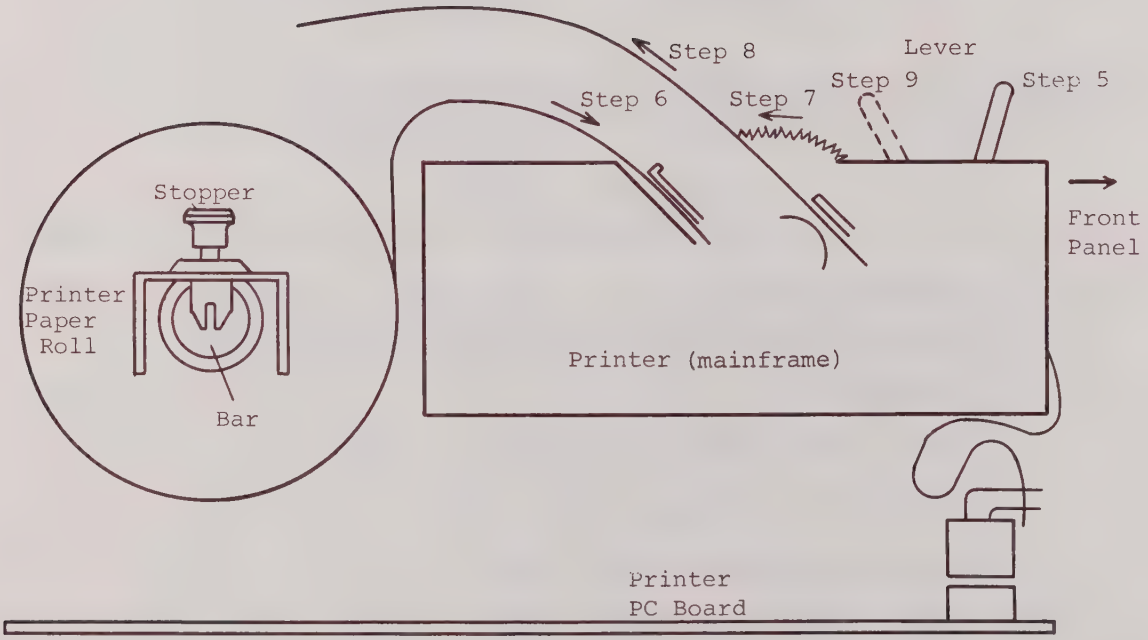


Fig. 3-14 Printer Unit Sectional Diagram
(Left Side View)

3.7.9 External plotter

The CRT screen can be directly output to a digital plotter by connecting it using a GP-IB (HP-IB) cable.

[PLOTTER]

Outputs CRT screen contents to external plotter

[P.START]

Starts output to external plotter

[HP/GP-GL]

Switches HP-GL and GP-GL

[P.ITEM]

Switches output contents

ALL : Entire CRT screen contents
GRAPH: Only graph

[END]

Terminates plot function

[P.RESET]

Stops command output to the plotter

Note that the plotter does not stop immediately.

To terminate operation forcibly, turn off the power to the plotter.

(1) Compatible plotters

(a) HP-GL (Plotter commands issued by HP)

HP models

7470A	Pen left :	Scale, character, and marker
	Right:	Graph
7475A	Pen 1:	Scale and character
7550A	2:	Graph
	3:	Marker

(b) GP-GL (Pen plotter commands issued by GRAPHTEC)
Personal plotter system only

GRAPHTEC FP5301 Pen 1: Scale and character
GD9411 2: Graph
3: Marker

Note:

ANRITSU does not provide plotters. Contact specified ploter manufacturers to make inquiries about plotters.

(2) Operation

(a) MS9001B/B1 or MS9002A (power off)

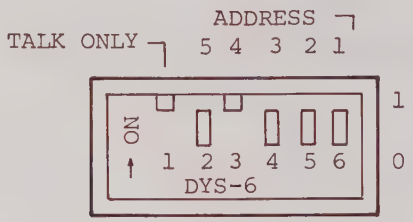


Fig. 3-15 Address Switch

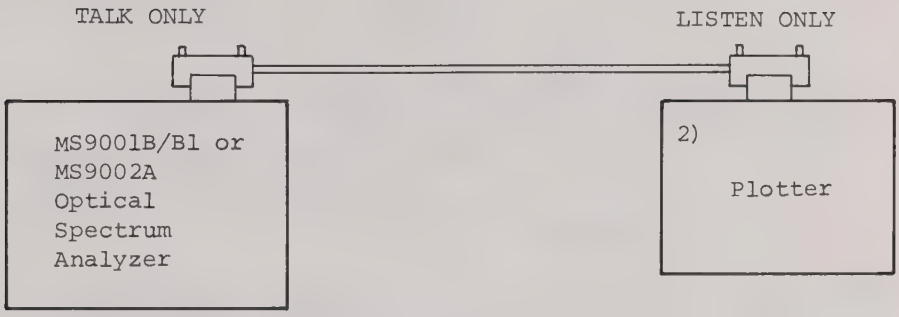
. Set the leftmost address switch (shown in the above figure) to 1 to set the GP-IB address to the TALK ONLY mode.

. Connect the GP-IB (HP-IB) cable.

(b) Plotter (power off)

. Set the GP-IB (HP-IB) address to the LISTEN ONLY mode.

. Connect the GP-IB (HP-IB) cable.



(c) Turn on the power

(d) Perform the various measurement.

(e) Press the ⌜BEGIN⌝ and ⌜PLOTTER⌝ keys.

The soft key functions and contents are displayed at the bottom of the CRT as follows:

```
  PLOTTER                    HP-GL      ALL

⌜P.START⌝ ⌜          ⌝ ⌜HP/GP-GL⌝ ⌜P.ITEM⌝ ⌜ END⌝
    ¦         ¦            ¦          ¦        ¦
   F1        F2           F3         F4       F5
```

(f) If the plotter commands are GP-GL, press the ⌜HP/GP-GL⌝ key and confirm that the display contents change to GP-GL.

If the commands are HP-GL, the display remains unchanged.

(g) Press the [P.START] key.

The plotter will then start plotting.

The soft key function display changes as follows:

[P.RESET] [ ] [ ] [ ] [ ]

At the end of plotting, the original status is restored.

(h) Perform the next measurement.

(i) To plot a graph over the previous one, press the [P.ITEM] key and confirm that the display changes to GRAPH.

Then press the [P.START] key to only plot graph.

For new plotting, press the [P.START] key at ALL. The entire CRT screen will be plotted.

Notes:

1. Turn off the power to the optical spectrum analyzer and plotter before setting the address switches or connecting the GP-IB (HP-IB) cable.

2. When the unit is set for direct output to the plotter, no computer can be connected for controlling the plotter.

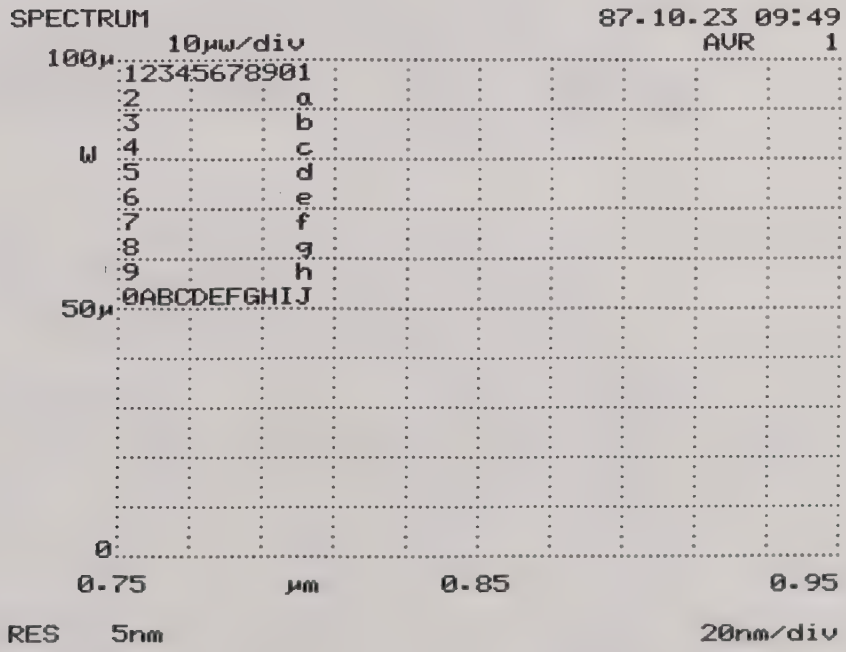
   To use computer control, release the optical spectrum analyzer and plotter from the TALK ONLY mode to make them addressable. (A program must also be created using the computer for plotting purposes.)

Notes (cont'd):

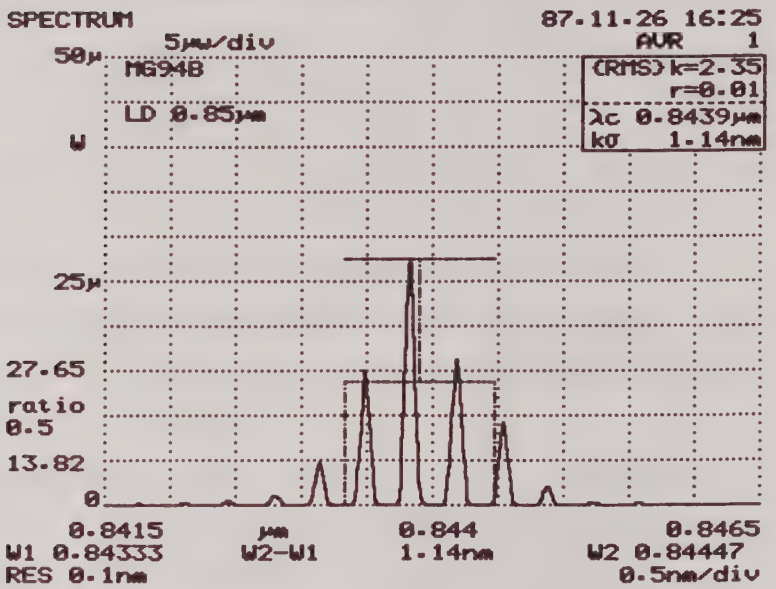
3. The HP-IB manufactured by HP is the same as the GP-IB.

4. A title to be output to the plotter consists of up to 11 characters and symbols on up to 10 lines at the upper-left corner of the graph area.

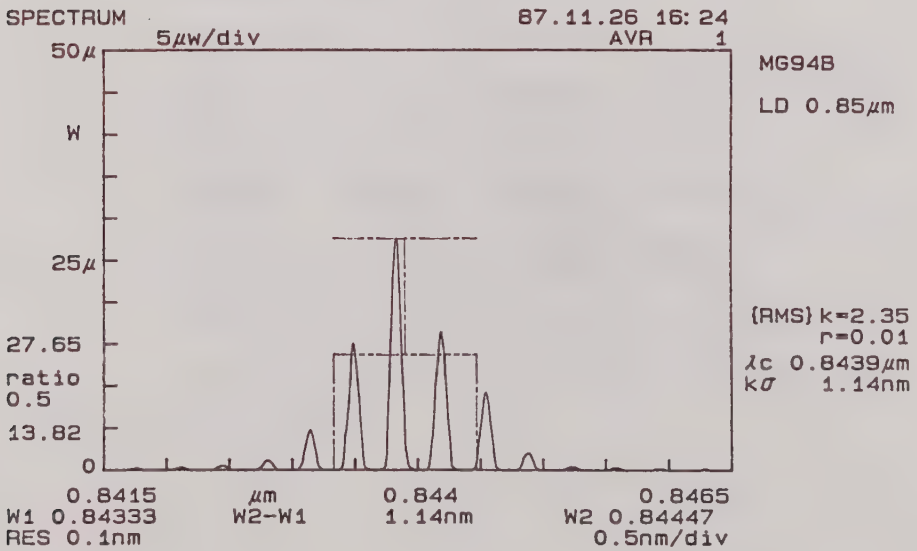
Characters and symbols are written at the upper-left corner and outside the scale on the plotter.



Example of Built-in Printer Output



Example of Plotter Output (7550A made by HP)
(Reduced from A4-size paper by 50%)



SECTION 4

MEASUREMENT

4.1 Spectrum Measurement

4.1.1 Connection

(1) Devices with optical connectors

Connect the device and the OPTICAL INPUT connector using optical fiber fitted with connectors at both ends.

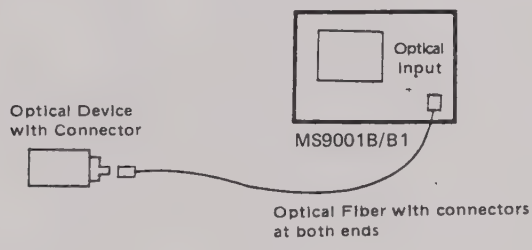


Fig. 4-1 Spectrum Measurement Connection for Devices with Optical Connectors

(2) For individual light emitting devices (LDs, LEDs, etc.)

Measurement can be made by bringing one end of the optical fiber into the vicinity of the light emitting device, and inserting the other end into the OPTICAL INPUT connector. By using the MA918A Light Emitting Element Measuring Unit, the device can be set up in one simple operation, direct connection with optical fiber can be done, and effective measurement can be made (paragraph 2.1.2).

If the light is weak, it is possible to increase the amount of light by using a lens to concentrate the light at the end of the optical fiber, or by using an optical fiber with a lens on the end. It is also possible to increase the amount of light by using an optical fiber with a large-diameter core; however, the resolution will deteriorate (paragraph 2.1.2).

For the relationship between the resolution and the diameter of the optical fiber, refer to paragraph 3.7.5 (3) (d). If the brightness is very weak, it may not be possible to obtain a satisfactory level, depending on the numerical aperture (NA) of the optical fiber, even if the light is concentrated by using a lens.

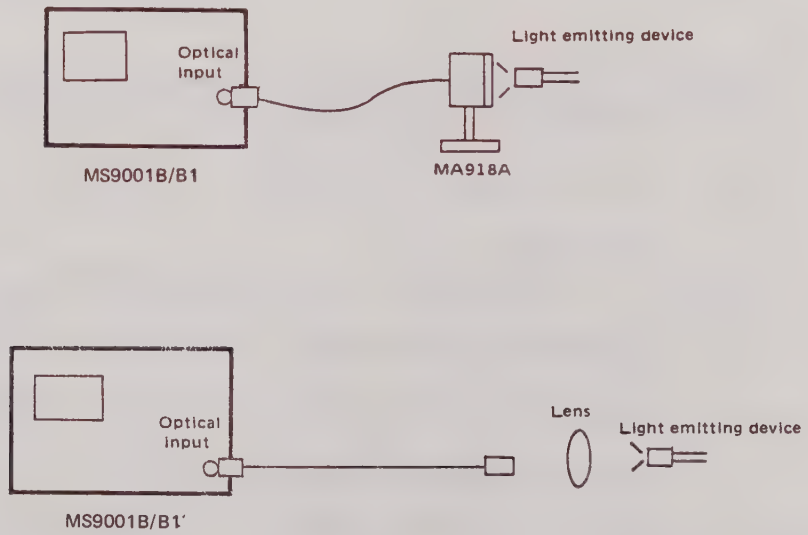


Fig. 4-2 Spectrum Measurement Connection for Individual Light Emitting Devices

4.1.2 Spectrum measurement

(1) Spectrum measurement by spectrum auto-ranging function

- Refer to paragraph 3.7.3.

(2) Spectrum measurement by conversation function

Operate the soft keys at the bottom of the CRT as described below.

1.3 μm LD light source spectrum measurement

Step	Procedure
1	Press the [CONVERSATION] key. Note: Thereafter, press the soft keys in accordance with the menu displayed at the bottom of the CRT.
2	Press the soft keys sequentially according to the underlines menu shown below. [LD] [LED] [LOSS] [TRANS] [END] [?] [0.85] [1.3] [1.55] [END] Measurement starts. At the end of measurement, the following message is displayed. [LD] [1.3] end For more information, read paragraph 3.7.4.

(3) Spectrum measurement by manual operation

This paragraph describes the method for manual measurement of spectra of unknown optical signals, and the output level and wavelength. (The spectrum auto ranging function and conversation function are not used in this case.)

Some measurement examples are listed below.

Paragraph	Measurement	Measured light
(b)	Center wavelength in linear mode	Multimode laser
(c)	Peak wavelength in linear mode	Multimode laser
(d)	Half-width wavelength in linear mode	Multimode laser
(e)	Spectrum drift in linear mode	Multimode laser
(f)	Laser diode spectrum analysis	Multimode laser
(g)	Side mode ratio in log mode	DFB laser

(a) Basic procedure

This paragraph describes the basic setting procedure that is used for all the measurement examples described in paragraphs (b) to (g). This basic procedure is the same as the procedure which is automatically carried out when the [SPECTRUM AUTO RANGING] or [CONVERSATION] key is pressed.

Step	Procedure
1	Insert power switch key into POWER switch and turn it clockwise to set to ON. The CRT display will change from BUSY to READY.
2	To measure in the maximum level and wavelength range, press the [LOG] and [SINGLE] keys in sequence. A waveform similar to that shown below will appear at LD measurement.

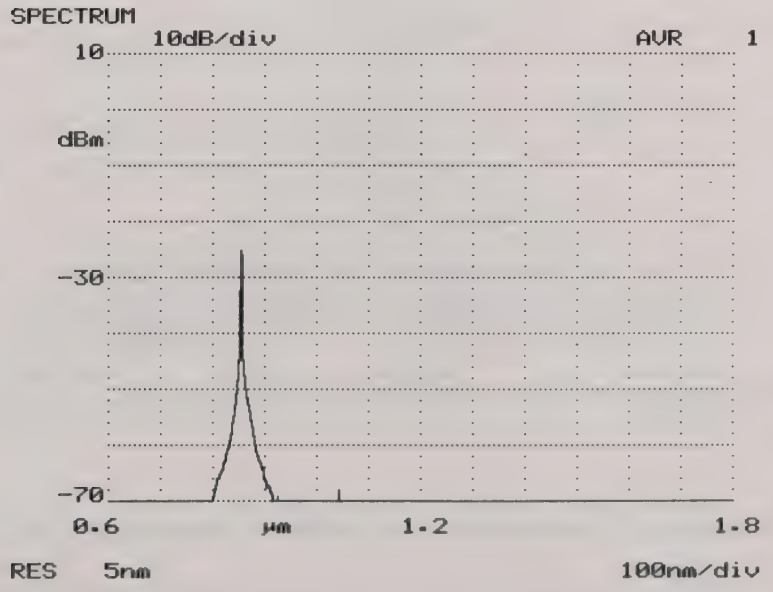


Fig. 4-3 Display in Maximum Level and Wavelength Range

Step	Procedure

3 Set maximum level wavelength to screen center by pressing [PEAK → CENTER] key.

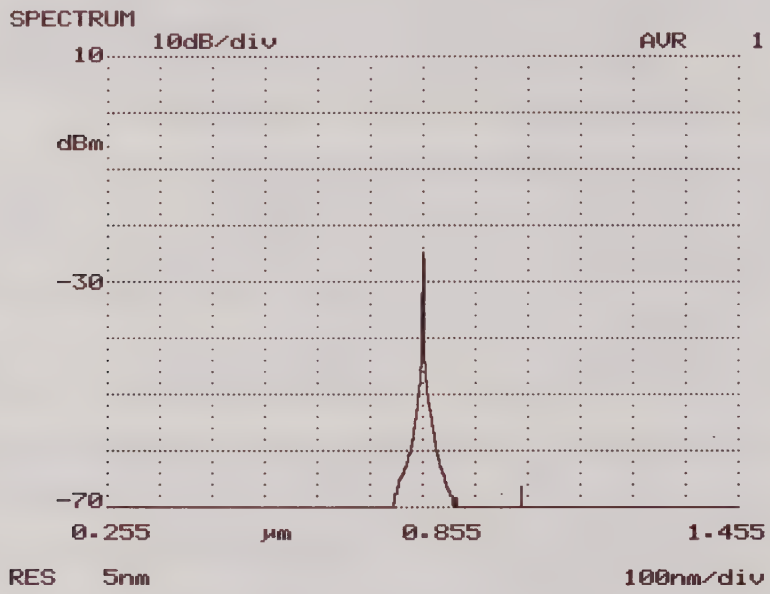


Fig. 4-4 [PEAK → CENTER] Key Operation in Log Mode

4 Press [SPAN] key and turn rotary knob to set span to 1 nm/div. (The span is displayed at the lower right of the screen.)

5 Set 0.1 nm resolution by pressing [RESOLUTION], [0], [.], [1], and [ENTER n] keys in this sequence.

Follow steps 6 to 9 (below) when measuring in the linear mode.

6 Press [LINEAR] key to enter linear mode.

7 Press [REPEAT] key to enter repeat sweep mode.

(Cont.)

Step	Procedure

8 Press [PEAK → LEVEL] key to set the maximum level to level range.

9 Press [PEAK → CENTER] key to set maximum level wavelength to screen center.

Follow steps 10 to 13 (below) when measuring in log mode.

10 Press [LOG] key to enter log mode.

11 Press [REPEAT] key to enter repeat sweep mode.

12 Press [PEAK → LEVEL] key to set the maximum level to reference level

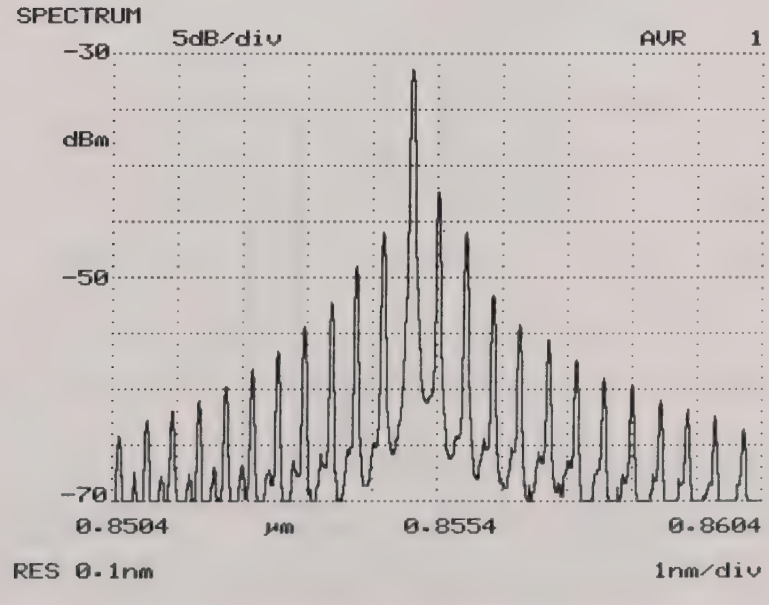


Fig. 4-5 [PEAK → LEVEL] Key Operation in Log Mode

13 Press [PEAK → CENTER] key to set the maximum level wavelength to screen center.

(b) Center wavelength measurement in linear mode

Included in the center wavelength measurement methods are the RMS method, the envelope method, the peak wavelength taken as the center wavelength method, the center value of the two biggest wavelengths at upper and lower half values taken as the center wavelength method, etc.

The last of the above-listed methods is described here.

Step	Procedure
1	Follow the basic linear mode procedure in paragraph (a).
2	Press [HALF CENTER] key to display half center wavelength.

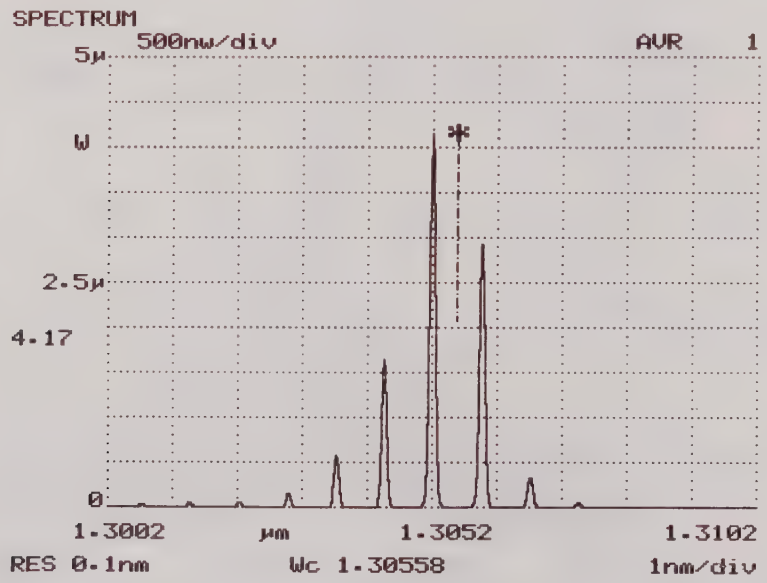


Fig. 4-6 [HALF CENTER] Key Operation in Linear Mode

The half center wavelength (Wc) is displayed at the bottom of the CRT. Its position on the waveform is marked by an asterisk (*). The mean value of two peak levels at this position is displayed on the left of the CRT.

(c) Peak wavelength measurement in linear mode

Step	Procedure
1	Follow the basic linear mode procedure in paragraph (a).
2	Press [PEAK SEARCH] key to display peak wavelength.

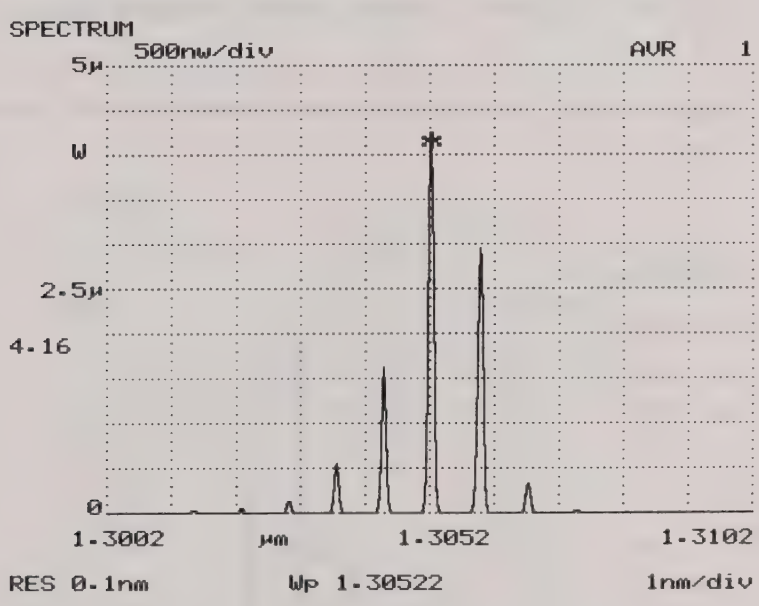


Fig. 4-7 [PEAK SEARCH] Key Operation in Linear Mode

The peak wavelength (Wp) is displayed at the bottom center of the CRT. Its position on the waveform is marked by an asterisk (*). The level at this position is displayed on the left of the CRT.

(d) Half-width wavelength measurement in linear mode

Included in the half-width wavelength measurement methods are the RMS method, the envelope method, and the half-level method. The half-level method is described here.

Step	Procedure
1	Follow the basic linear mode procedure in paragraph (a).
2	Press [HALF WIDTH] key to display half level marker line.

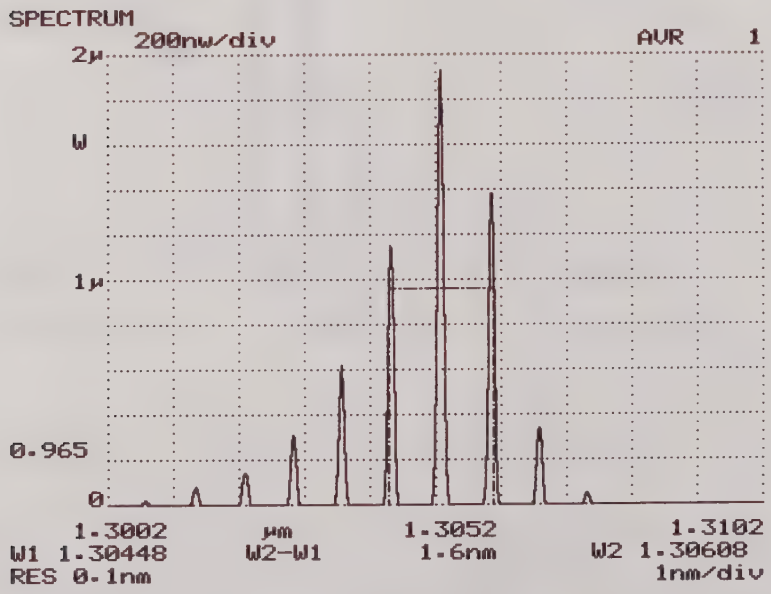


Fig. 4-8 [HALF WIDTH] Key Operation in Linear Mode

Half level wavelengthes W1 and W2 and the half-width value (W2 - W1) are displayed at the bottom of the CRT; its level is displayed at the left of the CRT.

(e) Spectrum drift measurement in linear mode

Step	Procedure
1	Follow the basic linear mode procedure in paragraph (a).
2	Press [REPEAT] key to enter the repeat sweep mode.
3	Press [SWEEP TIME] key for rapid sweep time. "FAST" is displayed at upper left of CRT.
4	Observe the spectrum drift.

Notes:

1. Refer to paragraph 4.3 for the sweep time.
2. To measure the drift of a single wavelength spectrum, set the spectrum to the center of the display and the span width to 0.

(f) Laser diode spectrum analysis

Step	Procedure
1	Use the ADVANCE functions. (Refer to paragraph 3.7.7.(5)
2	Press the [BEGIN] and [ANALYSIS] keys. Three types of analysis can be selected by using the soft keys.
3	Press the [RMS] key.

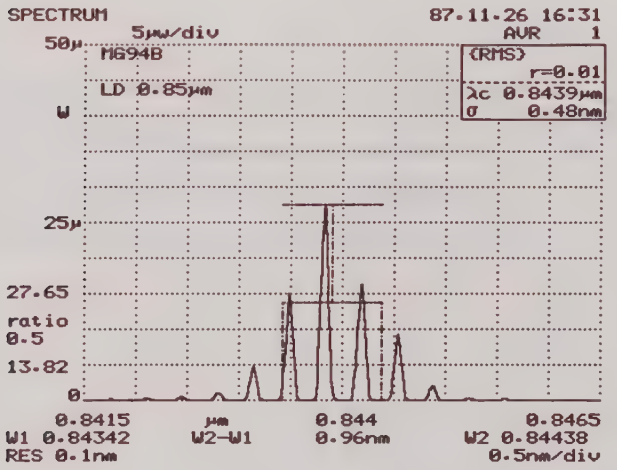


Fig. 4-9

Step	Procedure
3 (Cont)	The upper-right field of the CRT screen displays the center wavelength as λc and the deviation as σ.
4	Press the ⌜ENVELOPE⌝ key.

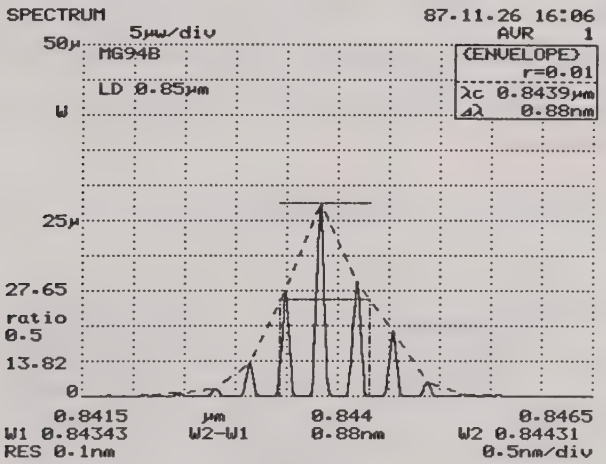


Fig. 4-10

The upper-right field of the CRT screen displays the center wavelength as λc and the half-value width as Δλ.

Always set the linerar scale before performing this operation.

Step	Procedure

4 (Cont) Note:

When the log scale is performed, the level marker indicating the half-value width and wavelength marker does not cross the envelope.

This is because the calculation is made according to linear data, although the envelopes are connected by a straight line on the log scale for display purposes.

5 Press the [ndB LOSS] key.

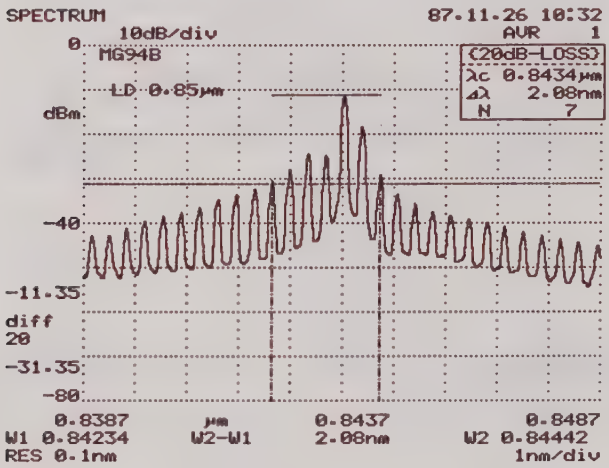


Fig. 4-11

The upper-right field of the CRT screen displays the center wavelength λc, the spectrum width as Δλ, and the number of spectra as N.

(Cont'd)

Step	Procedure
6	To change attenuation n, for example, press the [SCROLL], [S.LEVEL], [1], [5], [ENTER], [END], and [ndB LOSS] keys. The [ENTER] key sets 15 dB and the [ndB LOSS] key executes analysis and displays the results.
7	To hard-copy the CRT screen, press the [COPY] key.

(g) Side mode ratio measurement in log mode

The side mode ratio measurement requires a high dynamic range. Press the [HIGH SENSITIVITY] key when level accuracy is necessary and the side mode level is low (-50 dBm or less). Dc offset of the optical receiver output in the MS9001B/B1 is reduced. (Note that the measuring time increases. See paragraph 4.3.)

Step	Procedure
1	Follow basic log mode procedure in paragraph (a).
2	Press [PEAK SEARCH] key to search for peak level.
3	Press [ZERO ON OFF] key to set zero marker (▼).
4	Shift main marker to side mode peak by using rotary knob or [≪] and [≫] keys.
5	Read level difference which is displayed at the left of the CRT.

4.1.3 LD spectrum analysis

An LD spectrum can be analyzed by using the following three methods:

1. RMS method
2. Envelope method
3. ndB LOSS method

Notes:

1. This is applicable only to LDs.
2. The span must be 100 nm or less.
3. Coefficient r can be set within the range of 0.001 to 0.999 to determine the assumed spectrum level.

   The value is common to all three methods and is initially set as 0.01. In this case, a spectrum whose value is 0.01 times as small as the maximum spectrum value is regarded as the spectrum to be calculated.

(1) RMS method

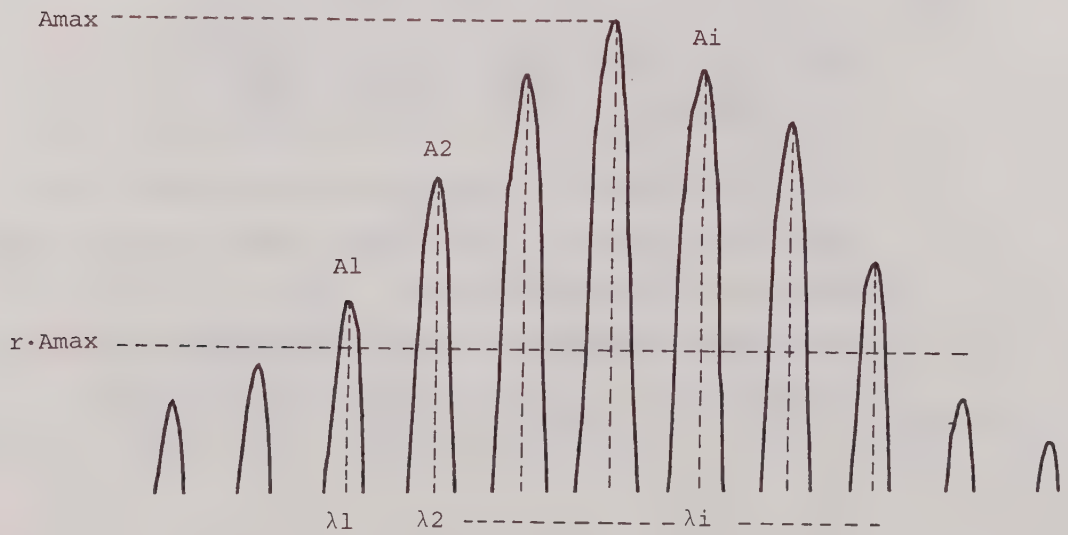


Fig. 4-12

(a) Spectrum measurement

Calculate level value Ai and wavelength λi of a spectrum whose value is more than r times the maximum value Amax.

(b) Calculation of center wavelength λc

$$\lambda c = \frac{\Sigma Ai \cdot \lambda i}{\Sigma Ai}$$

(c) Calculation of spectrum width σ (standard deviation)

$$\sigma = \sqrt{\frac{\Sigma Ai\ \lambda i^2}{\Sigma Ai} - \lambda c^2}$$

(d) Display

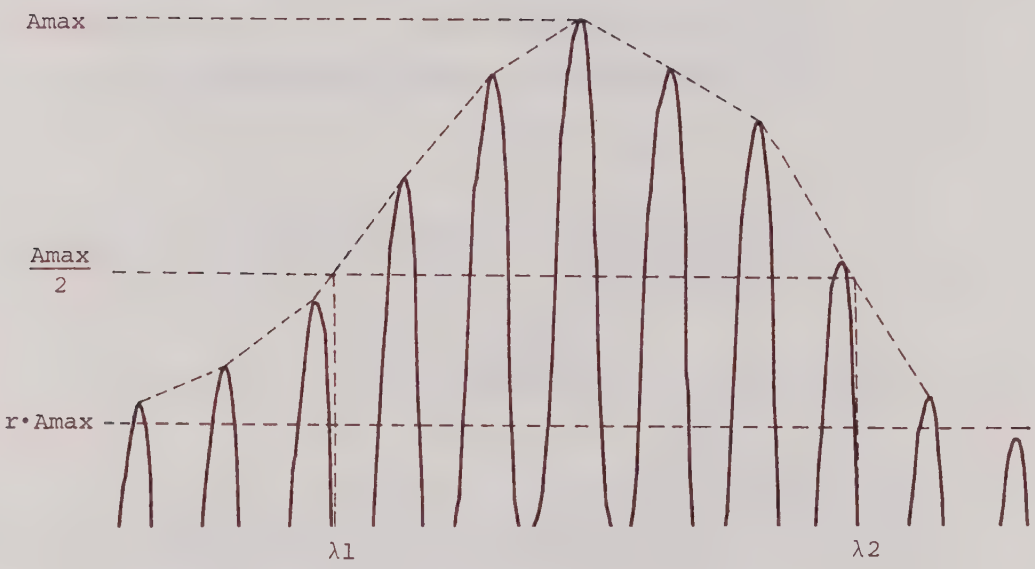
The calculation value is selected from σ, 2σ, 2.35σ, and 3σ for display. Here, 2.35σ corresponds to the half-value width of the normal distribution curve. For exact calculation, 2.354820 is used.

The displayed calculation results are rounded up to 0.01 nm.

The wavelength marker is set and displayed at the λc position and W1 and W2 are set and displayed at the position in accordance with the following:

	σ, 2σ	2.35σ	3σ
W1	λc - σ	λc - 1.1774σ	λc - 1.5σ
W2	λc + σ	λc + 1.1774σ	λc + 1.5σ

(2) Envelope method



(a) Spectrum measurement

For spectra whose values are r or more times as large as the maximum value (Amax) of each spectrum on the linear scale, to draw an envelope, connect spectra by a dashed line.

Calculate the points where the half level of Amax crosses this envelope for wavelengths λ1 and λ2. (λ1<λ2)

(b) Calculation of center wavelength λc

$$\lambda c = \frac{\lambda 1 + \lambda 2}{2}$$

(c) Calculation of spectrum half-value width

$$\Delta\lambda = \lambda 2 - \lambda 1$$

(d) Display

The envelope is displayed by a dashed line.

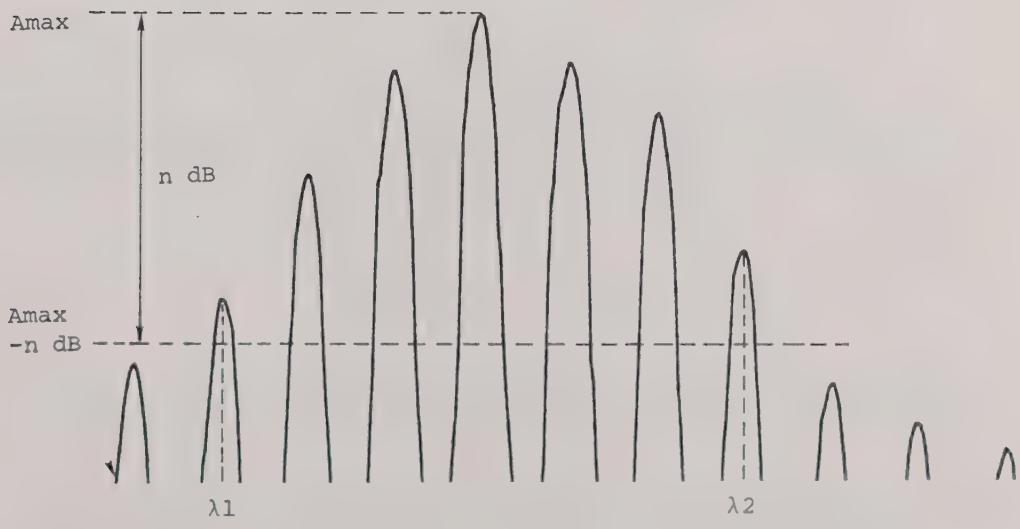
The level markers are displayed at the peak level value and its half-value level value.

The wavelength marker displays W1 and W2 at the positions of $\lambda 1$ and $\lambda 2$.

Note:

The cross point between the half-value level value and wavelength marker does not overlap with the envelope connected by a stright line when setting the log scale because it is calculated on a linear scale.

(3) ndB LOSS method



(a) Spectrum measurement

Make the minimum wavelength λ1 and the maximum wavelength λ2 for a spectrum whose value is larger than Amax-n dB (smaller than maximum value of Amax by n dB).

(b) Calculation of center wavelength λc

$$\lambda c = \frac{\lambda 1 + \lambda 2}{2}$$

(c) Calculation of spectrum width

$$\Delta\lambda = \lambda 2 - \lambda 1$$

(d) Display

The level markers are displayed at the peak level value and the level value by n dB below the peak level value.

The wavelength markers W1 and W2 are displayed at the positions of λ1 and λ2.

N indicates the number of spectra.

Note:

Level difference n can be input with the numeric keys.

Numerics that can be input are an integer from 1 to 25, 27, or 30.

4.2 Wavelength-Loss Characteristics Measurement

4.2.1 Connection

When measuring wavelength-loss characteristics, it is necessary to make a connection for the measurement-system internal characteristics measurement (which include short-length fiber), and also a connection for the loss measurement (which includes the fiber loss to be measured), between a wideband light source (MG922A White Light Source) and the MS9001B/B1 (Fig. 4-12).

The white light source is provided from the OPTICAL OUTPUT connector on the front panel of the MG922A. Internally, the light source is connected to the OPTICAL OUTPUT by a multi-component optical fiber with a core diameter of 600 μm. Depending upon the device to be measured, a larger dynamic range may sometimes be obtained by using a fiber with a large core diameter; however, the resolution will deteriorate. For the relationship between resolution and core diameter, see paragraph 3.7.5 (3) (d).

(1) Devices with optical connectors

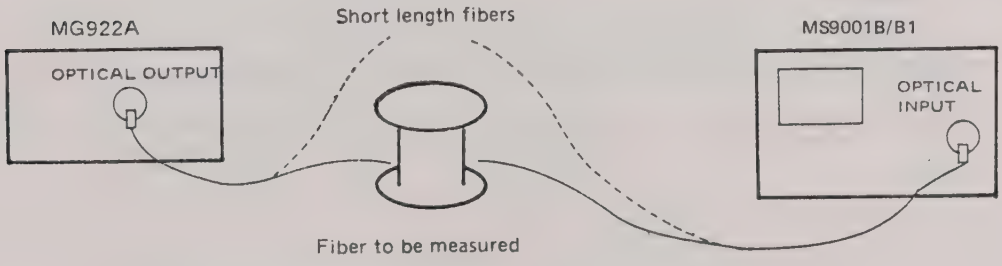


Fig. 4-12 Connection for Devices with Optical Connectors

Insert a dummy fiber if necessary. If an optical connector is necessary when performing measurement at the end of an optical fiber, use the MP915A Fiber Adapter.

(2) Devices without optical connectors

Use the MA919B Parallel Beam Mount. As shown in Fig. 4-13, the MA919B is used for converting the light from the optical fiber into a parallel beam, and vice versa. Assess the internal characteristics of the measurement-system after removing the device to be measured.

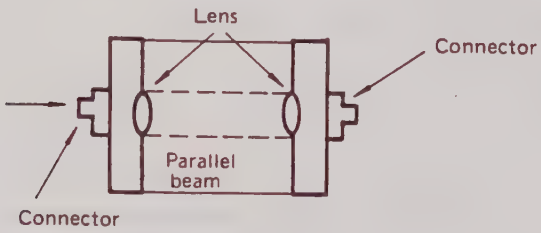


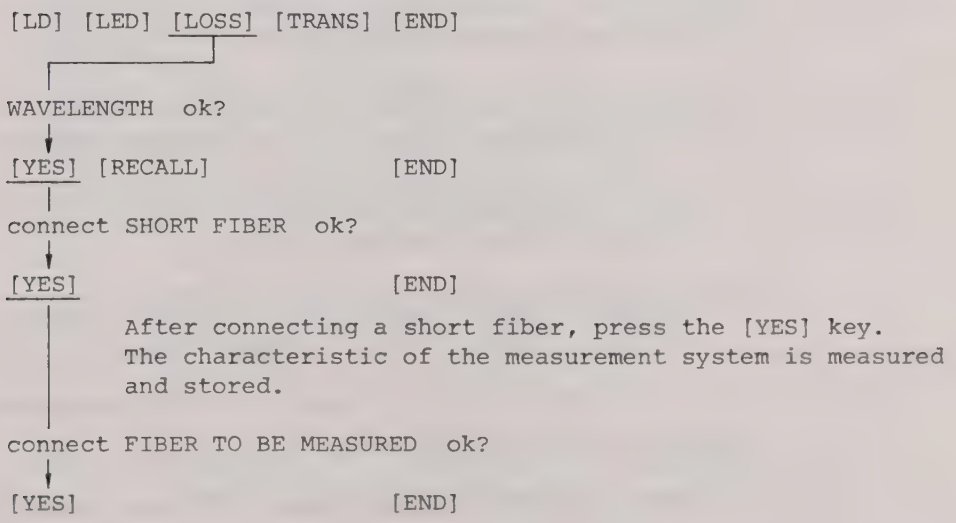
Fig. 4-13 MA919B Parallel Beam Mount

4.2.2 Wavelength-loss characteristics measurement

This paragraph describes the measurement of wavelength-loss characteristics with optical fiber as an example. For such measurement, it is necessary to use a wideband light source such as the MG922A White Light Source. The measuring sequence consists of measurement of the internal characteristics of the measurement-system (reference data), followed by the measurement of the fiber loss.

(1) Wavelength-loss characteristics measurement by conversation function

Step	Procedure
1	Before starting measurement, check the wavelength range. At the first measurement, or to change the previous wavelength setting, set the wavelength as described in paragraph 3.7.5 (1), then proceed as described below.
2	Press the [CONVERSATION] key.
3	Operate in accordance with the messages and soft keys menu displayed at the bottom of the CRT. (Press the underlined soft keys shown below.)


[LD] [LED] [LOSS] [TRANS] [END]
WAVELENGTH ok?
[YES] [RECALL] [END]
connect SHORT FIBER ok?
[YES] [END]
After connecting a short fiber, press the [YES] key.
The characteristic of the measurement system is measured and stored.
connect FIBER TO BE MEASURED ok?
[YES] [END]

After replacing the short fiber with the fiber to be measured, press the [YES] key. The characteristic of the (measurement system + fiber to be measured) is measured and stored.

(Cont.)

Step	Procedure
4	After measurement, the display changes to the loss characteristics screen, the graph is displayed, and the operation ends. For more information, read paragraph 3.7.4.

(2) Wavelength-loss characteristics measurement by manual operation

Step	Procedure
1	Turn on power and wait for display to change from BUSY to READY.
2	Set the measurement wavelength as follows: Press the [CENTER], [1], [.], [2], and [μ] keys in sequence to set 1.2 μm center wavelength. Press [SPAN] key and turn rotary knob to set 1200 nm span (sweep width).
3	Press [RESOLUTION], [5], and [ENTER] keys in sequence to set 5 nm resolution if necessary.
4	Set measurement level range in accordance with input optical level as follows: Press [LOG] key and set 2 dB/div scale by turning rotary knob. Press [REFERENCE LEVEL], [+/-], [4], [0], and [ENTER] keys in sequence to set -40 dB reference level.

(Cont.)

Step	Procedure
4 (cont.)	Note: When the level is low, align the averaging setting as indicated below: Press [AVERAG TIME], [1], [0], [0], and [ENTER] keys in this sequence to set averaging time of 100 for low input level.
5	Press [2 REF] key to specify data memory 2.
6	Connect MG922A output to MS9001B/B1 input by using a short fiber.
7	Press [SINGLE] key to set single sweep. Measurement starts and measured data is stored at data memory 2.
8	After measurement by one sweep is completed, press [3 MER] key to specify data memory 3.
9	Connect MG922A output to MS9001B/B1 input by using fiber to be measured.
10	Press [SINGLE] key to set single sweep. Measurement starts and measured data is stored at data memory 3.
11	After measurement by one sweep is completed, display fiber loss characteristics by pressing [LOSS] key.
12	Use marker if required to measure wavelength and level of any chosen point.
13	Print-out the data if required.

4.3 Measuring Time

The measuring time of this instrument is automatically set in accordance with the sweep width, measuring level and HIGH SENSITIVITY, and AVERAGING function settings. The following is an outline of the measuring times for this instrument.

The measuring time varies as shown below.

Table 4-1 Measuring Time

Measuring Time	Fast	Slow
Measuring mode	Linear	Log
Number of averagings	Few	Many
High sensitivity	OFF	ON
Sweep time	ON (FAST)	OFF (NORMAL)
Scan width (Span)	Narrow	Wide

Examples:

1. LD spectrum measurement

Setting	Measuring Time
Span 2 nm, linear, fast:	0.3 s
Span 10 nm, linear:	0.4 s
Span 10 nm, log, fast:	0.4 s
Span 10 nm, log:	5 s
Span 10 nm, log, high-sensitivity on:	25 s

Note: Averaging 1

2. LED spectrum measurement

Span 100 nm, averaging 1, linear, high-sensitivity off,	0.8 s

3. Wavelength-loss characteristics measurement

Span 1.2 μm, averaging 10, log, 1 sweep, high-sensitivity on:	1 min.

SECTION 5

PRINCIPLES OF OPERATION

5.1 Overall

The block diagram of this instrument is shown in Fig. 5-1.

This instrument consists of a light diffraction section, diffraction grating drive section, optical receiving section, control section processing section, and CRT. The light from an optical input is spectrally divided by the light diffraction section, converted into an electric signal by the optical receiving section, and then displayed on the CRT after processing by the processing section.

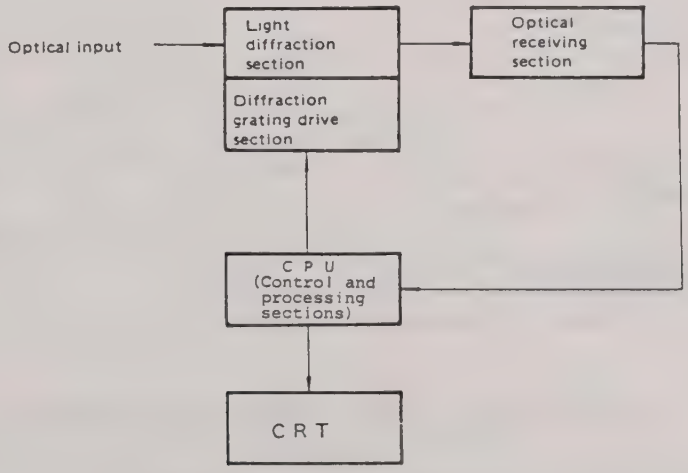


Fig. 5-1 MS9001B/B1 Block Diagram

5.2 Light Diffraction Section

This instrument uses a diffraction grating to split light into its spectral components. A diffraction grating consists of a glass sheet, or similar material, onto which fine grooves are cut. Light striking the grating is diffracted at an angle determined by its wavelength. The light diffraction section construction in this instrument is shown below.

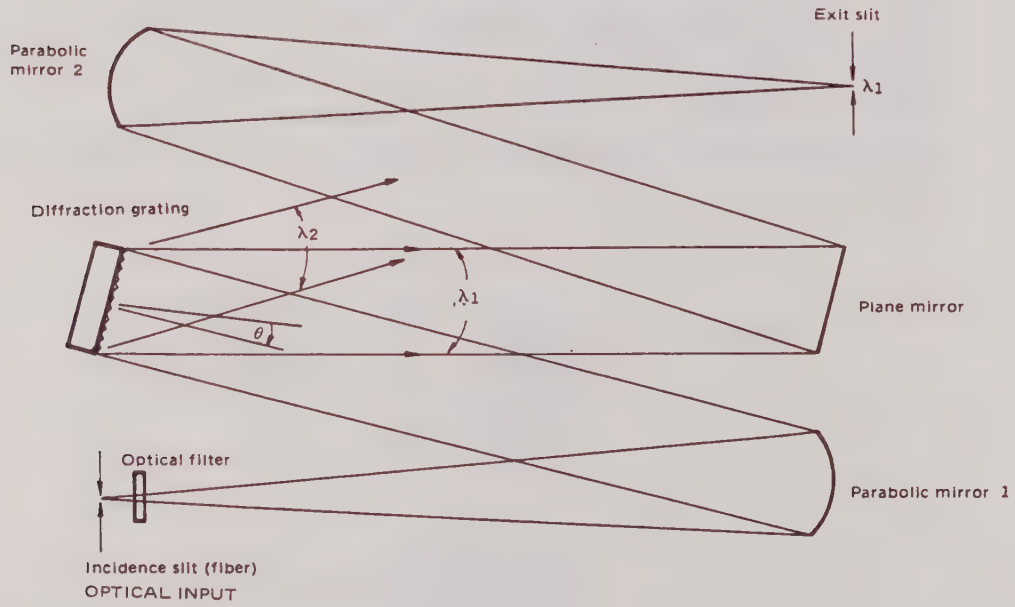


Fig. 5-2 Light Diffraction Section

The light enters the light diffraction section from the OPTICAL INPUT terminal, is converted into a parallel beam by parabolic mirror 1, and then strikes the diffraction grating. The diffracted light is focused on the exit slit by parabolic mirror 2. Behind the exit slit are optical receivers. As shown in the drawing, if the direction of the diffraction grating is fixed, only a

single wavelength of the light which enters the optical receiver will be detected. If, however, the diffraction grating is rotated, it is possible to establish a relationship between wavelength and the angle of rotation. Then, wavelength-optical level characteristics can be obtained.

5.3 Diffraction Grating Drive Section

The diffraction grating is rotated by a servomotor at high speed and accuracy. The block diagram of the diffraction grating drive section is shown below.

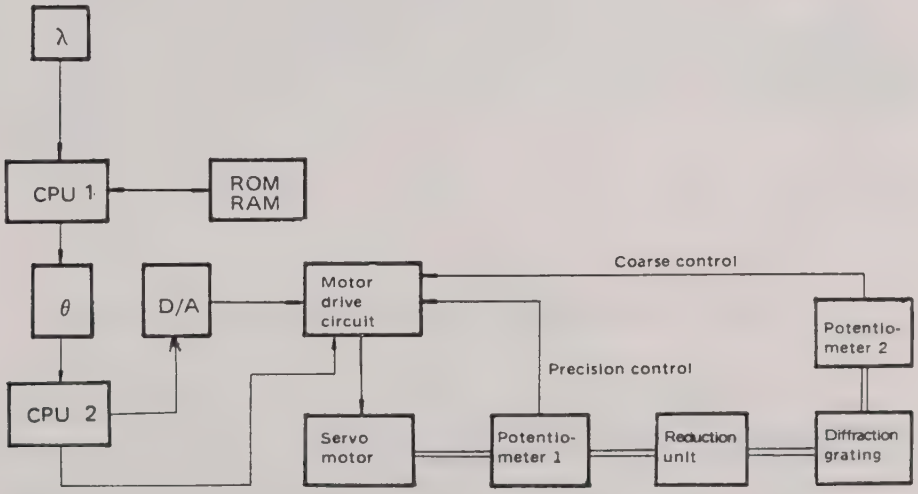


Fig. 5-3 Block Diagram of Drive Section of Diffraction Grating

When the wavelength (λ) is set by the front panel key, CPU1 calculates the angle to be applied to the diffraction grating, and sends the data to CPU2. CPU2 sets data to the D/A converter to rotate the servo-motor by using the motor drive circuit. The angle is detected by a potentiometer, forming the servomechanism.

5.4 Optical Receiving Section

The composition of the optical receiving section is as shown below.

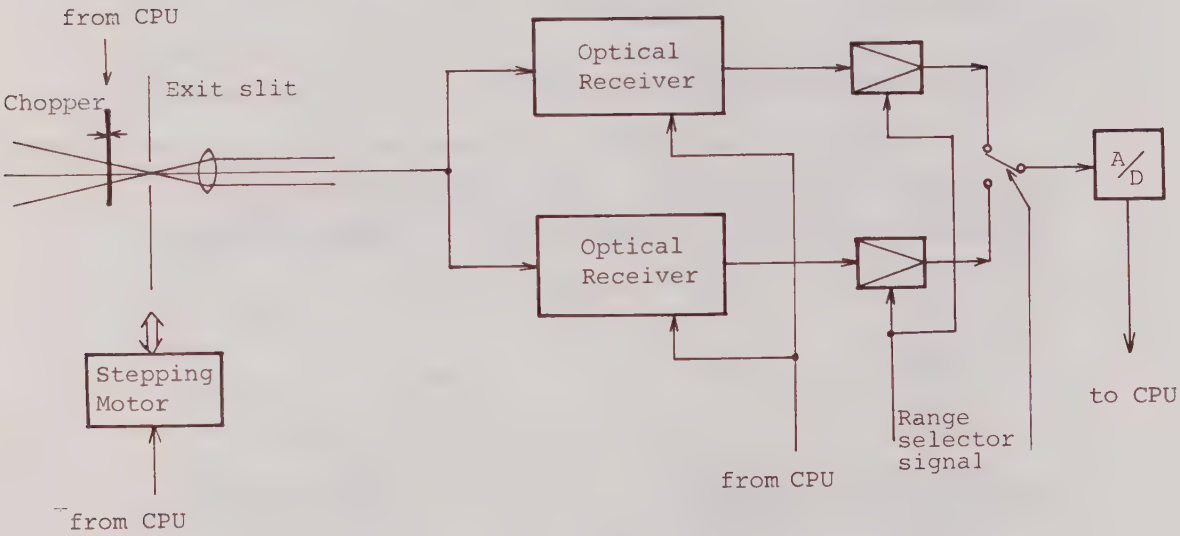


Fig. 5-4 Block Diagram of Optical Receiver

The light which is split at light diffraction section, is chopped by means of a chopper. The purpose of this is to cancel the dc offset output current of the light receiving section.

Then a single wavelength of the light which is diffracted by the light diffraction section is selected by the exit slit. The resolution is determined by the width of the slit, which is precisely controlled by a stepping motor.

The optical system after the exit slit does not depend on the polarization characteristics of the incident light.

The light receiving section uses an Si-PIN for short wavelengths, and a ternary-APD for long wavelengths for noise reduction. Switching is done by an optical switch.

5.5 Processing Section and CRT

To increase processing speed, the control and processing section uses a 16 bit CPU.

This section controls the optical section, logarithmic conversion, and necessary calculations for peak search, peak level, and wavelength half-width; it also controls the GP-IB.

The CRT displays the results of measurement subsequent to calculation and messages of extended function (ADV. FUNCTION and CONVERSATION), using 280 dots vertically and 580 dots horizontally.

SECTION 6

PERFORMANCE TEST

6.1 Introduction

A performance test is conducted to check whether the main functions of the MS9001B/B1 meet the specifications. This section gives a list of the equipment required for the performance test and explains how each test is conducted.

If the performance check results meet every specification, the MS9001B/B1 is ready for normal use. If a test does not meet a specification, contact Anritsu or representative in your area.

The performance test items are as follows.

1. Measuring wavelength range
2. Measuring level range
3. Measuring level accuracy
4. Linearity
5. Dynamic range (Stray light level)
6. Wavelength accuracy
7. Resolution bandwidth
8. Memory backup
9. Memory backup function

6.2 Equipment Required for Performance Tests

Table 6-1 Equipment Required for Performance Tests

Equipment	Major Specification	Reference Paragraph
MG9601A Standard Wavelength GENERATOR	He-Ne gas laser Ne (Neon) lamp Hg (Mercury) lamp Kr (Krypton) lamp Ar (Argon) lamp Output level: ≧-70 dBm (To 200 µm core diameter)	6.4.1 6.4.2 6.4.6 6.4.7
MG94B Light Source	Light wavelength: 0.85 ±0.01 µm Output level: -3 ±1 dBm Light-emitting element: LD Half-value width: ≦3 nm	6.4.2, 6.4.3, 6.4.4, 6.4.7,
MG921A Light Source	Light wavelength: 1.3 ±0.02 µm Output level: -6 dBm or more Half-value width: ≦5 nm	6.4.2, 6.4.3, 6.4.4, 6.4.7,
Optical band-pass Filter (1.75 µm)	Center transmission wavelength: 1.75 µm Half-value width: 15 nm	6.4.2
MG922A Light Source	Output level: -45 dBm/5 nm, at 0.7 to 1.6 µm -55 dBm/5 nm at 0.4 to 1.6 µm Light-emitting element: Halogen lamp	9.4.2
MG923A Light Source	Light-emitting wavelength: 1.5 ±0.03 µm Half-value width: ≦10 nm Output level: -6 dBm or more	6.4.2, 6.4.3, 6.4.4, 6.4.7,

Table 6-1 Equipment Required for Performance Tests (Continued)

Equipment	Major Specification		Reference Paragraph
MG99B (Not required if MG9601A) Light Source	Output level:	≧-15 dBm to SM fiber ≧-8 dBm to GI fiber	6.4.7
	Light wavelength:	6328 µm	
ML93B (MA95A, MA96E MA97B, MA98A) Power Meter (Sensor)	Sensor wavelength range (µm)	Min. level (dBm)	6.4.2, 6.4.3, 6.4.4
	MA95A 0.38 to 1.15	-90	
	MA96E 0.75 to 1.8	-80	
	MA97B 0.38 to 1.15	-65	
	MA98A 0.75 to 1.8	-40	
1.1523 µm He-Ne laser (with FC connector)	Light wavelength:	1.1523 µm (with FC connector)	6.4.5, 6.4.7
		1.523 µm (with FC connector)	6.4.5, 6.4.7
1.523 µm He-Ne laser (with FC connector)	Output level:	≧-15 dBm to SM fiber	
MN924A Optical Attenuator	Wavelength: 1.3/1.55 µm		6.4.2, 6.4.3, 6.4.4
	Maximun attenuation:	65 dB	
	Step attenuator:	10 dB x 5	
	Continuous variable attenuator:	0 to 15 dB	

Table 6-1 Equipment Required for Performance Tests (Continued)

Equipment	Major Specification	Reference Paragraph
FC-2-2M-SM SM Optical Fiber Cord	10/125 µm, 2 m FC connector at both end	
FC-2-2M-GI GI Optical Fiber Cord	50/125 µm, 2 m FC connector at both end	
SM-200-FVD-95P Large Diameter Optical Fiber Cord	200/750 µm	

6.3 Preparation

Turn the power on and warm-up the MS9001B/B1 for more than 30 minutes.

6.4 Performance Test

6.4.1 Measuring wavelength range

(1) Specification:

0.6 to 1.75 µm

(2) Setup

(3) Procedure

Confirm that the 0.6030 µm (Ne lamp), 1.7110 µm (Hg lamp), and 0.8777 µm (secondary light: Kr lamp) spectral lines can be measured with an accuracy of ±1 nm with the following settings.

- Measure 0.6030 µm (Ne) and 1.7110 µm (Hg) with the resolution set to 0.5 nm (for primary-light measurement).
- Measure 0.8777 µm (Kr) with the resolution set to 0.2 nm (for secondary-light measurement).
- Increase averaging time as required.
- See the measurement example below for details of other MS9001B/B1 settings.

Measured data Example:

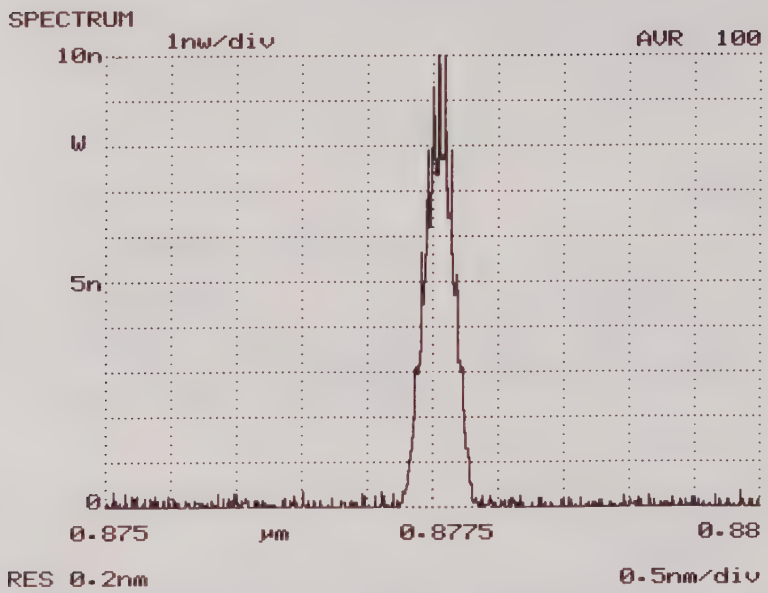


Fig. 6-1 Measuring Wevelength Range Test

6.4.2 Measuring level range

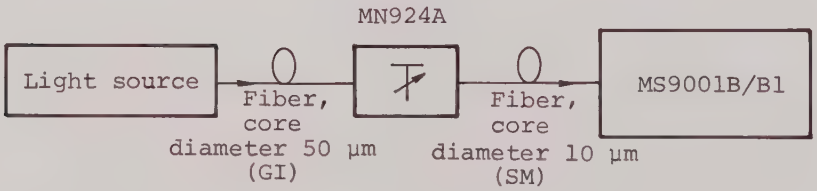
(1) Specification

+10 to -70 dBm (0.7 to 1.6 μm at a resolution of ≧0.5 nm)

+10 to -65 dBm (0.6 to 0.7 μm at a resolution of ≧0.5 μm)

+10 to -55 dBm (1.6 to 1.75 μm at a resolution of ≧0.5 nm)

(2) Setup



0.63 μm MG99B or MG9601A
0.85 μm MG94B
1.3 μm MG921A
1.55 μm MG923A
1.75 μm (Band pass filter + MG922A)

(3) Procedure

Step	Procedure
1	Set the resolution of MS9001B/B1 to 5 nm. See measured data example below for details of the other settings.
2	Confirming the input level by using the ML93B at the following wavelength, check the measuring level range.

Wavelength (μm)	Level [dBm]	Average Time	Level stability [dB]
0.63	-70	1000	±2
0.85	-70	1000	±2
1.3	-70	1000	±2
1.55	-70	1000	±2
1.75	-55	1000	

Press the [HIGH SENSITIVITY] key for low-level measurements.

Note:

The +10 dBm measurement is not explained here because it requires special equipment.

Measured data example:

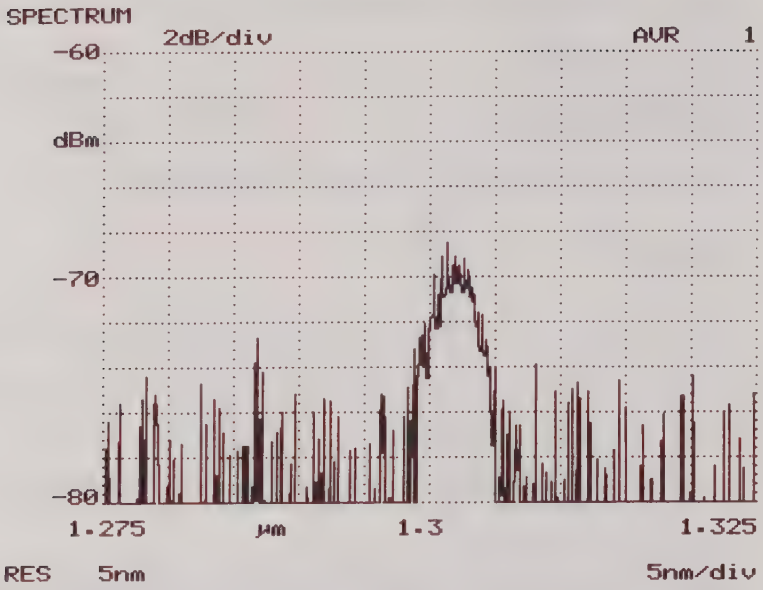


Fig. 6-2 Measuring Level Range Test

6.4.3 Measuring level accuracy

(1) Specification

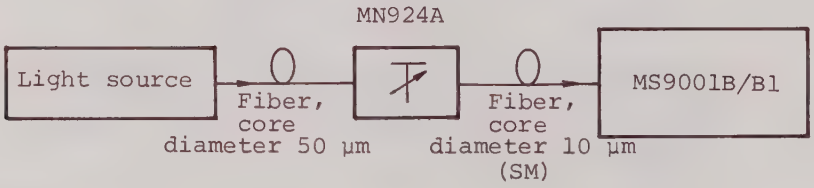
±2 dBm (0.85, 1.3, and 1.55 μm)

In this case, input level: -30 dBm

SM fiber

resolution: 0.2 to 5 nm

(2) Setup



0.85 μm MG94B

1.3 μm MG921A

1.55 μm MG923A

The light emitting bandwidth must be narrower than the set resolution. (Most spectral light must be within 5 nm bandwidth).

(3) Procedure

Step	Procedure
1	Set the MS9001B/B1 resolution to 5 nm. See the measured data example below for details of the other settings.
2	Confirming the input level by using the ML93B, check the measuring level accuracy.

Measured data example:

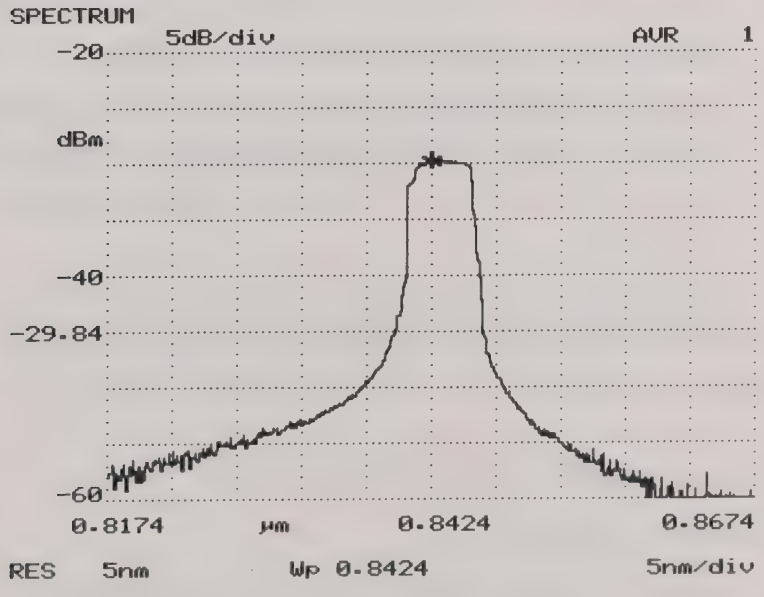
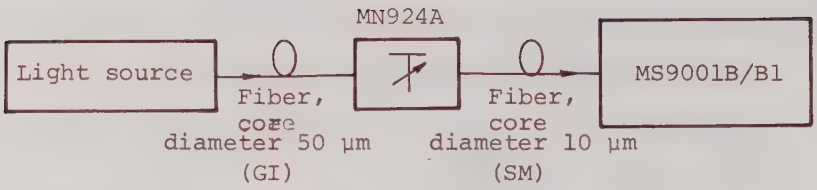


Fig 6-3 Measuring Level Accuracy Test

6.4.4 Linearity

(1) Specifications ±3 dB/60 dB
±1 dB/20 dB
±0.5 dB/10 dB

(2) Setup



0.85 µm (MG94B)
1.3 µm (MG921A)

(3) Procedure

Step	Procedure
1	Set the resolution MS9001A to 5 nm.
2	Measure and confirm the input level difference at every 10 dB in the same range by using the ML93B. Then measure the linearity error by using the MS9001A.
3	Calculate the differences at every 20 dB and 60 dB from the values measured at every 10 dB.

6.4.5 Dynamic range (Stray light level)

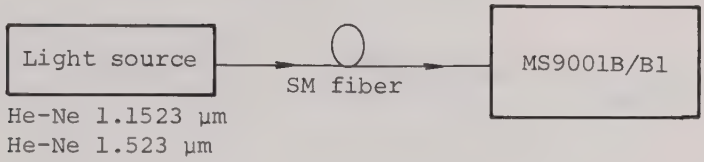
(1) Specification

MS9001B		MS9001B1	
≧35 dB	*1	≧40 dB	*1
≧45 dB	*2	≧50 dB	*3

*1 Difference between peak level and level at ±1 nm on either side of peak for SM fiber, resolution bandwidth 0.1 nm, and wavelength 1.1523 and 1.523 µm

*2 Difference between peak level and level at ±10 nm an either side of peak for SM fiber, resolution bandwidth 0.1 nm, and wavelength 1.1523 and 1.523 µm

(2) Setup



(3) Procedure

Step	Procedure
1	Set the MS9001B/B1 resolution to 0.1 nm and the average time to 10.
2	Set the high sensitivity mode to ON.
3	See the measured data example below for details of other setting.
4	Confirm the specification.

*3 Difference between peak level and level at ±5 nm an either side of peak for SM fiber, resolution bandwidth 0.1 nm, and wavelength 1.1523 and 1.523 µm

Measured data example:

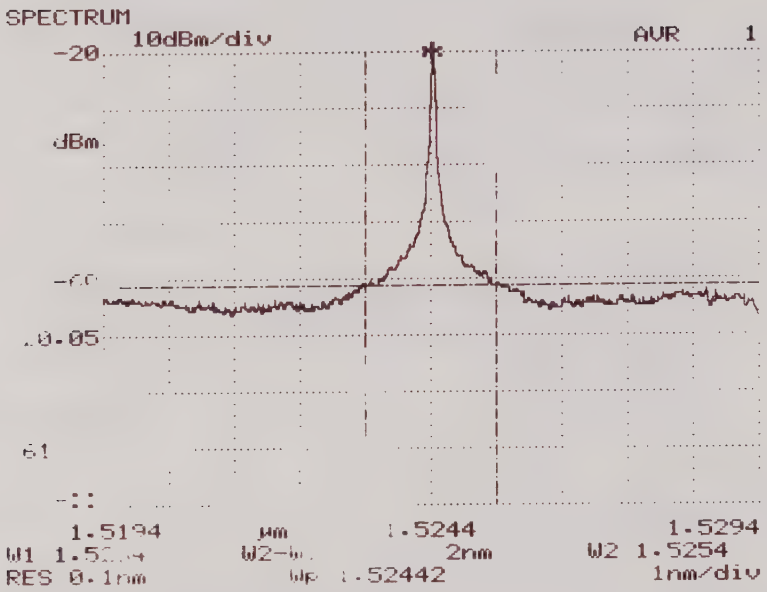


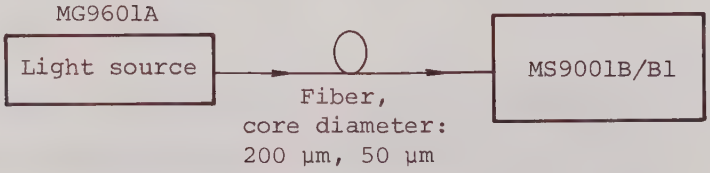
Fig. 6-4 Dynamic Range (Stray Light Level) Test

6.4.6 Wavelength accuracy

(1) Specification

±0.5 nm (25°C), ±1 nm (10° to 40°C)

(2) Setup



Because the light source has a low output level, use a fiber with a core diameter of 200 μm (except with He-Ne gas laser).

(3) Procedure

Step	Procedure
1	Set the resolution to 0.5 nm for primary light, and 0.2 nm for secondary light.
2	See the measured data example for details of the other settings.
3	Use the MG9601A light Source to check that the following wavelengths can be measured with an accuracy of ±0.5 nm (25°C) or ±1 nm (10° to 40°C). The * mark indicates that the primary and secondary lights should both be measured.

Wavelength (μm)	Light source
0.603	He Lamp
0.6328*	He-Ne
0.6678*	Ne Lamp
0.7032*	Ne Lamp
0.7635*	Ar Lamp
0.8265*	Ar Lamp
0.8521*	Ar Lamp
0.9225	Ar Lamp
0.9784	Ar Lamp
1.1286	Hg Lamp
1.3570	Hg Lamp
1.3673	Hg Lamp
1.3951	Hg Lamp
1.5296	Hg Lamp
0.8777*	Kr Lmap

Measured data example:

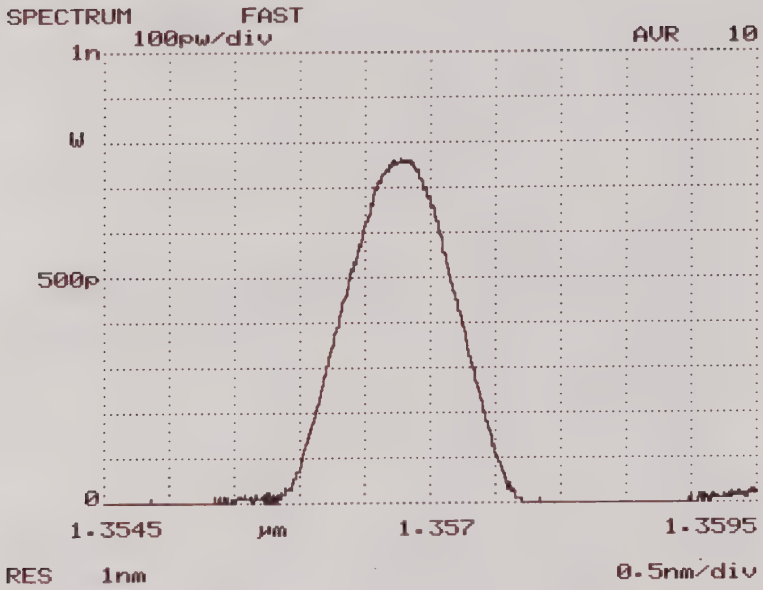


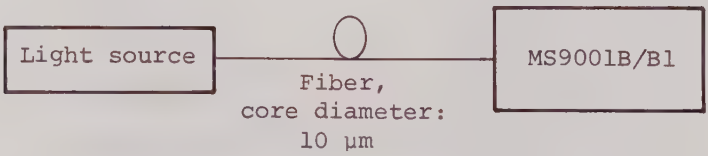
Fig. 6-5 Wavelength Accuracy Test

6.4.7 Resolution bandwidth

(1) Specification

0.1, 0.2, 0.5, 1.0, 2.0, and 5.0 nm

(2) Setup



(3) Procedure

The resolution bandwidth is the same as the half-value width.

Measure the half-value width to confirm that the following resolution bandwidths can be obtained for the corresponding wavelengths. (See the measured data example for details.)

Wavelength (Light Source)	Resolution Bandwidth
0.63 µm (MG99B or MG9601A)	5.0 nm ±20%, 0.5 nm ±20% 2.0 nm ±20%, 0.2 nm ±30% 1.0 nm ±20%, 0.1 nm ±50%
0.85 µm (MG94B)	0.2 nm ±30% 0.1 nm ±50%
1.1523 µm (He-Ne, MG9601A)	5.0 nm ±20%, 0.5 nm ±20% 2.0 nm ±20%, 0.2 nm ±30% 1.0 nm ±20%, 0.1 nm ±50%
1.3 µm (MG921A)	0.5 nm ±20% 0.2 nm ±30% 0.1 nm ±50%
1.55 µm (MG923A)	0.5 nm ±20% 0.2 nm ±30% 0.1 nm ±50%

Measured data example:

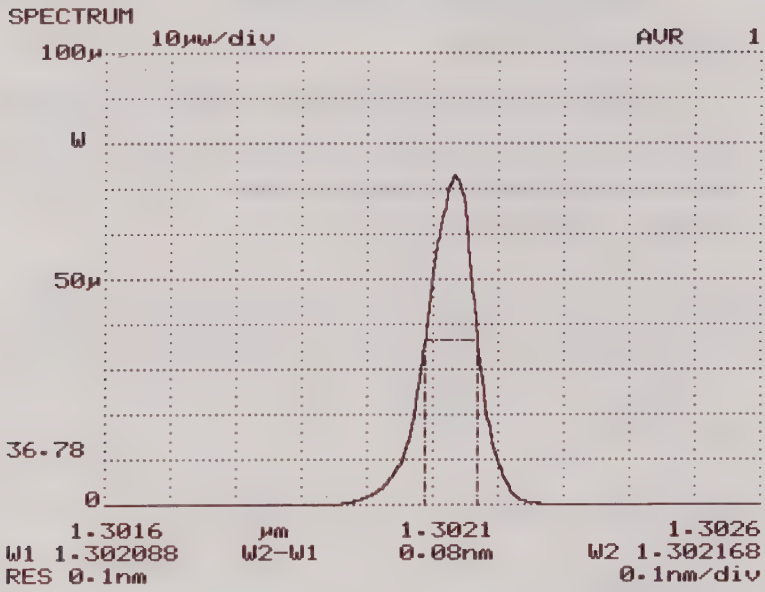


Fig. 6-6 Resolution Bandwidth Test (1)

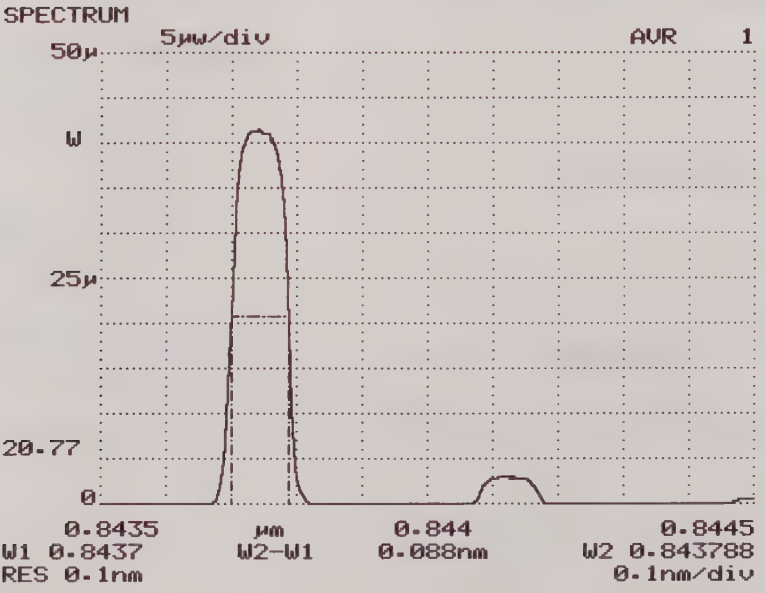


Fig. 6-7 Resolution Bandwidth Test (2)

6.4.8 Memory backup function

(1) Function

Data memory (measuring conditions + measured data) 3

Memories 1 to 9 (measuring conditions)

(2) Procedure

Step	Procedure
1	Save the measured waveform data or measurement conditions in each memory.
2	Recall saved data and check that it was saved connectly.

APPENDIX A

OPTIONAL ACCESSORIES

1. Fiber fitted with one-way selfoc lens

This fiber has a lens at one end and an optical plug at the other, and efficiently collects parallel light transmitted through free space (core diameter 50 or 200 μm.) When used in reverse, light from the fiber is transformed into a parallel beam.

The coupling efficiency is 2 dB. Light from an LD is not parallel, so it cannot be measured using this equipment, but a gas laser can be measured with it. The lens diameter is 1.8 mm.

Fibers:

(1) OPCL-5G100-FC

For parallel beam

With FC type plug

NA 0.19

Core diameter 50 μm

GI fiber

(2) OPCL-20H100-FC

For parallel beam

With FC type plug

NA 0.50

Core diameter 200 μm

2. Large Diameter Optical Fiber Cord (FC type plug each end)

This fiber enables efficient collection of light from a small diameter optical fiber.

The collected light quantity is proportional to the square of the fiber diameter (d^2), but the maximum measuring wavelength resolution is degraded. Consequently, it is used to measure light from LEDs and lamps at low resolution (paragraph 4.7.5(3)(d)).

The core diameters available are: 200, 400, 600, and 800 μm; 200 μm is most popular.

It is composed of multi-component glass.

Type	Core Diameter [μm]	Fiber Diameter [μm]
SM 200 - FVD - 95 P	200	250
SM 400 - FVD - 95 P	400	500
SM 600 - FVD - 95 P	600	750
SM 800 - FVD - 95P	800	1000

Step index fiber shown below is used.

NA 0.2, refraction index 1.452

Attenuation 10 dB/km max. (at 0.85 μm)

Mitsubishi-Densen, Japan

3. Measuring fiber cord

This fiber has FC plugs at both ends.

SM and GI fibers, listed below, are available.

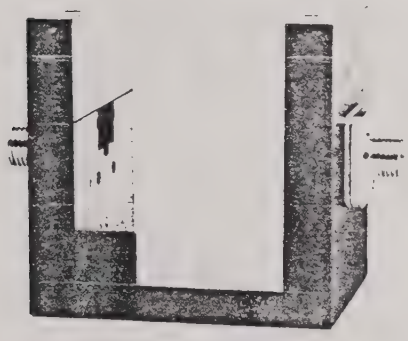
FC-[*1]-[*2]M-GI	GI 50/125, NA 0.2
FC-[*1]-[*2]M-SM	SM 10/125, NA 0.1

*1; Assign 1 for FC plug at one end
Assign 2 for FC plugs at both ends

*2; Fiber cord length (1, 2, or 3 m available)

APPENDIX B

MA919B PARALLEL BEAM MOUNT



The MA919B emits light from an optical fiber into free space, forms it into a parallel beam, then returns it to an optical fiber. By inserting a filter between the two fibers, the wavelength loss characteristics can be measured.

The MA919B is designed for a fiber with a core diameter of 50 μm and a NA 0.2. The measuring wavelength range is 0.6 to 1.6 μm. Coupling efficiency is approx. 2 dB at 0.85 and 1.3 μm. Measured Sample is shown below.

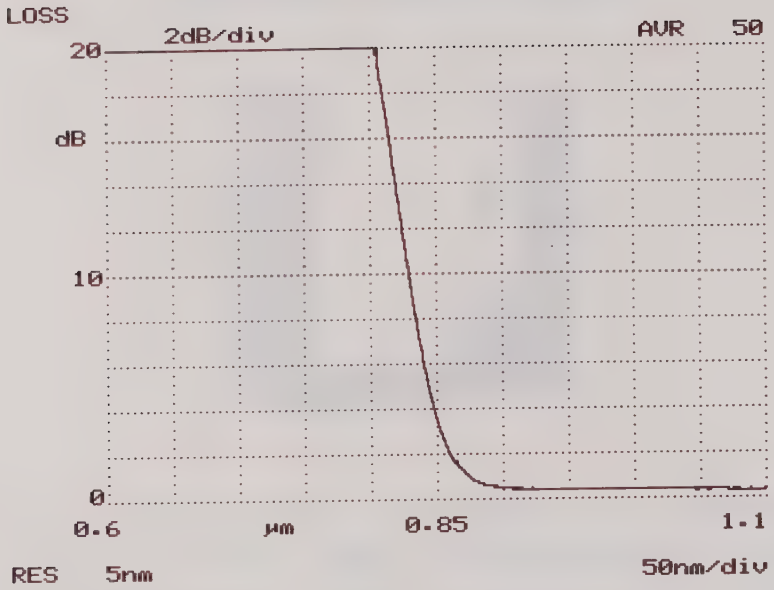


Fig. B-1 Wavelength-Loss Characteristics of 0.85 μm Optical Filter

APPENDIX C

MP915A FIBER ADAPTER

The MP915A is attached to an optical fiber core end to connect the fiber to an FC connector.

Applied fiber: Clad diameter 125 ±3 μm
Jacket diameter 0.3 to 1.0 mm

APPENDIX D

MA918A LIGHT EMITTING ELEMENT MEASURING UNIT

The MA918A is used for measuring spectral characteristics of an optical element not coupled to a connector.

It couples the light from the element to a fiber and is composed of two parts: one is the head to hold an optical element and the other is a main frame to hold a fiber.

The element can be installed in one simple operation, which permits immediate connection to a fiber. Compatible heads for a variety of optical elements are available on request.

The MA918A does not uses a lens, and it has a coupling efficiency of -30 dB, which is enough for measuring spectra.

APPENDIX E

MG922A WHITE LIGHT SOURCE

This light source is used in combination with the MS9001B/B1 Optical Spectrum Analyzer to measure wavelength loss characteristics.

Features:

Light extending over a wide band is generated and sent at high efficiency ($\geq$ -45 dBm/10 nm) to the optical fiber.

Application:

As a wideband light source for wavelength loss measurement.

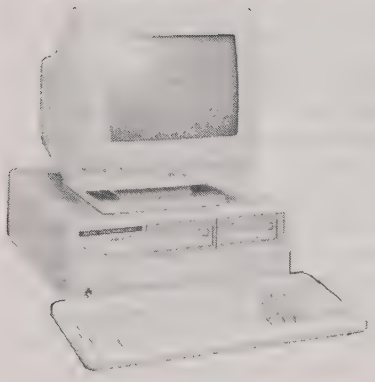
Specifications

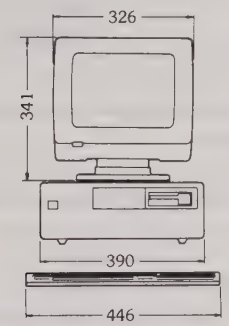
Light/Source	Halogen Lamp
Optical Output	$\geq$ -45 dBm/10 nm (Fiber: GI 50/125, NA = 0.2)
Optical Connector	FC type
Light Wavelength Range	0.6 to 1.6 µm
Power Supply	** Vac ±10%, 50/60 Hz, $\leq$ 160 VA
Dimensions and Weight	213 W x 133 H x 250 D mm, $\leq$ 7 kg

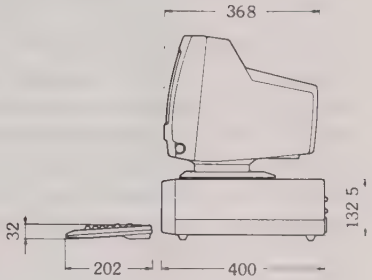
** V: Specify one nominal ac line voltage between 100 and 250 V when ordering.

APPENDIX F

PACKET V PERSONAL TECHNICAL COMPUTER







(Unit: mm)

(Packet VF)

Major specifications

Main unit

Item	Product name		
	PACKET VF (MC1201A)	PACKET VH (MC1202A)	PACKET VB (MC1203A)
CPU	68000 (clock frequency 8 MHz)		
Memory	ROM: 32KB RAM: 512KB (no-wait) 14MB maximum (with expansion box, 1 clock wait added) VRAM: 128KB for graphics 16KB for characters CMOS RAM: 1K x 4 bits (battery backup)		
Display functions	Interface: Separate video outputs (one connector for both color and monochrome displays) Resolution: 640 x 400 dots Character fonts: Alphanumeric 6 x 10 dots Character screen: 80 characters x 25 lines Graphics screen: Page mode 4 screens (can be superimposed) RGBI mode 1 screen Both character and graphics screens can be superimposed. Monochrome display: 16 gradations Colors: RGBI mode: 15 colors Page mode: 2 colors (for each graphics screen)		

Major specifications (cont.)

Main unit (cont.)

Item	Product name		
	PACKET VF (MC1201A)	PACKET VH (MC1202A)	PACKET VB (MC1203A)
Clock	Year/month/day/hour/minute/second/day-of-week (backed up by a lithium battery for longer than 7 years)		
Timer	10ms resolution		
Counter	1ms resolution		
Tone generator	Frequency: 200 Hz to 15 kHz Duration: 2ms to 32.767s Volume control: 0 to 30 dB (relative value) with triad and noise generators		
Auxiliary storage	One 3.5" floppy disk drive (640KB) (Additional drive is available as option.)	One 3.5" hard disk drive (20MB) One 3.5" floppy disk drive (640KB)	One bubble cassette drive (128KB) One bubble memory board (512KB)
Expansion slots	3 slots (VME bus type)		
Operating conditions	Temperature: 5° to 45°C		Temperature: 0° to 50°C
	Humidity: 20% to 80% (no condensation)		
Power	85 to 132 V or 170 to 264 V, 47 to 63 Hz		
	130 VA	170 VA	150 VA
Dimensions	132.5H, 390W, 400D (mm)		
Weight	8.5 kg	10.0 kg	9.0 kg
Options	Additional 3.5" floppy disk drive (640KB)	—	—

Major specification (cont.)

CRT display

Item	Product name	
	Monochrome display monitor (MC3601A)	Color display monitor (MC3602A)
Screen size	12 inches	12 inches
Color	Amber	15 colors (RGBI)
Resolution	640 dots (horizontal) x 400 dots (vertical)	
Tilt	0° to 20° (vertical)	
swivel	±45° (horizontal)	
Horizontal sync. frequency	24.83 kHz	
Vertical sync. frequency	56.4 Hz	
Operating conditions	Temperature: 0° to 50°C	Temperature: 5° to 45°C
	Humidity: 20% to 80% (no condensation)	
Power consumption	85 to 264 V, <50 VA	90 to 130 V or 180 to 260 V, <100 VA
Dimensions	341H, 326W, 363D (mm)	
Weight	9 kg	11.2 kg

Major specification (cont.)

Keyboard

Item	Product name	
	ASCII keyboard (MC3302A)	Hand held control panel (MC3303A)
Type	Low profile cylindrical step sculpture	Splash-proof flat panel
Number of keys	107	31
Key type	ASCII keys, ten numeric keys, edit keys, control keys, and function keys	Ten numeric keys, function keys, cursor keys, clear key
Operating conditions	Temperature: 0° to 50°C	
	Humidity: 20% to 80% (no condensation)	
Power consumption	0.75 W	0.51 W
Dimensions	32H, 446W, 202D (mm)	25H, 85W, 160D (mm)
Weight	1.5 kg	200 g
Mouse controller (MC0304A)	Available as an option	

Item	Product name
	Mouse controller (MC0304A)
Type	2-key mechanical mouse
Resolution	0.25 mm/count
Power consumption	<0.1 W
Interface	Mouse controller (MC0304A)

Major specification (cont.)

Peripheral equipment

Product name	Specifications
Expansion box (MC8101A)	Number of slots: 9 (8 for users and 1 for interface) Slot specifications: Conforms to VME bus standard Dimensions: 245H, 390W, 250D (mm) Number of units: 2 units Power: 24 A at 5 V, 1.8 A at +12 V, 1.8 A at -12 V
5" floppy disk drive (MC2101A)	Number of drives: 2HD x 2 (1MB/drive) Dimensions and weight: 88H, 390W, 250D (mm), 10 kg Power consumption: <30 VA Interface: Connected to MC0177A
8" floppy disk drive (DFD7740A)	Number of drives: 2 (1MB/drive) Dimensions and weight: 250H, 240W, 387D (mm), 15 kg Power consumption: <150 VA Interface: Connected to MC0177A
Hard disk drive (DDS7745B)	Memory capacity: 20MB Dimensions and weight: 170H, 240W, 387D (mm), 11 kg Power consumption: <120 VA Interface: Connected to MC0178A
Printer (DPR7713A)	Print method: Impact dot matrix (9 x 9) Print speed: 160 characters/second Dimensions and weight: 95H, 420W, 347D (mm), 8 kg Power consumption: <100 VA Interface: GP-IB or Centronics interface

APPENDIX G

POLAROID CAMERA

Camera	Adapter	Manufacturer	Remarks
197B	10378A	HP	Can be used by directly mounting on the CRT hood of the MS9001B/B1
C-5C	016-0357-01	TEKTRONIX	
C-59 AP	016-0249-04	TEKTRONIX	
C-28	016-0249-04	TEKTRONIX	

APPENDIX H

MB23A PORTABLE TEST RACK

By eash operation of the lever, the table can be inclined at five different angles for optimum instrument viewing ease. Thanks to Anritsu's exclusive construction, just a light touch of the lever is all it takes to move the angle safely up to 45°.

Specifications

Model		MB23A
Folding capability		Yes
Dimensions and weight of instrument to be mounted	Weight	40 kg
	Dimensions	350H x 426W x 450D mm
Tilt angle		-10°, horizontal, +15°, +30°, +45°
Casters	Wheel diameter	ø102 mm
	Stopper	At front wheel
Weight (without option)		≦15 kg
Power source outlets		Five outlets

* Since a two-prong power outlet is standard, those wishing other arrangements should contact their Anritsu representative. (In such cases, fewer outlets can be attached.)

GP-IB MANUAL

OPTICAL SPECTRUM ANALYZER

MS9001B/B1

ANRITSU CORP.

TABLE OF CONTENTS

		Page
SECTION 1	GENERAL	1-1
SECTION 2	GP-IB FUNCTIONS	
2.1	GP-IB Functions	2-1
2.2	Serial Polling	2-1
SECTION 3	GP-IB ADDRESS	3-1
SECTION 4	DEVICE MESSAGES	
4.1	Explanation of Device Messages	4-1
4.1.1	Header (HR) field	4-1
4.1.2	Numeric (NR) field	4-1
4.1.3	Separator (SR) field	4-2
4.2	Sample Programs	4-2
4.2.1	WRITE statement	4-2
4.2.2	Read statement	4-3
SECTION 5	DEVICE MESSAGE DETAILS	
5.1	START	5-1
5.2	STOP	5-3
5.3	CENTER	5-5
5.4	SPAN	5-6
5.5	PEAK → CENTER	5-9
5.6	MARK → CENTER	5-10
5.7	ΔW → SPAN	5-11

TABLE OF CONTENTS (Cont'd)

		Page
5.8	RESOLUTION	5-12
5.9	LINEAR	5-14
5.9.1	In case of spectrum measurement or display setting	5-14
5.9.2	Transmission factor measurement or display setting	5-16
5.10	EXPAND	5-18
5.11	LOG	5-19
5.12	REFERENCE LEVEL	5-21
5.13	PEAK → LEVEL	5-24
5.14	HIGH SENSITIVITY	5-24
5.15	AVERAGE TIME	5-25
5.16	SWEEP TIME	5-25
5.17	SPECTRUM	5-26
5.18	TRANSMISSION	5-27
5.19	LOSS	5-28
5.20	GRAPH DISPLAY	5-30
5.21	DATA MEMORY	5-30
5.22	GRAPH & MARKER CLEAR	5-37
5.23	MAIN MARKER	5-37
5.24	LEVEL MARKER 1	5-39
5.24.1	Linear scale setting	5-39
5.24.2	Log scale setting	5-40
5.25	WAVELENGTH MARKER 2	5-42
5.25.1	Linear scale setting	5-42
5.25.2	Log scale setting	5-43

TABLE OF CONTENTS (Cont'd)

		Page
5.26	WAVELENGTH MARKER 1	5-45
5.27	WAVELENGTH MARKER 2	5-46
5.28	PEAK SEARCH	5-48
5.29	HALF CENTER	5-49
5.30	HALF WIDTH	5-51
5.31	SINGLE	5-53
5.32	REPEAT	5-53
5.33	STOP (SWEEP MODE)	5-54
5.34	MARKER/FULL	5-57
5.35	INITIAL	5-58
5.36	SPECTRUM AUTO RANGING	5-59
5.37	COPY	5-62
5.38	FEED	5-64
5.39	ANALYSIS	5-65
5.40	TIME	5-67
5.41	TITLE	5-68
SECTION 6	SAMPLE PROGRAMS	6-1
6.1	LD Light Source Spectrum 1	6-1
6.2	LD Light Source Spectrum 2	6-4
APPENDIX	DEVICE MESSAGES LIST	A-1

SECTION 1

GENERAL

The MS9001B/B1 Optical Spectrum Analyzer has a GP-IB (General Purpose Interface Bus) conforming IEEE std. 488-1978. The MS9001B/B1 also conforms to IEC625-1 specifications if a connector conversion adapter (sold separately) is fitted to the GP-IB interface connector.

Since the measurement functions can be externally controlled via the GP-IB, an automatic measuring system can be built by connecting a personal computer.

Note:

The GP-IB is described in detail in the document "Introduction to GP-IB System" available from your local representative.

SECTION 2

GP-IB FUNCTIONS

2.1 GP-IB Functions

The MS9001B/B1 Optical Spectrum Analyzer GP-IB functions are listed below.

SH1 Source handshake function provided

AH1 Acceptor handshake function provided

T8 Talker function provided, talk only function not provided

L4 Listener function provided, listen only function not provided

RL1 Remote/local function provided

SR1 Serial poll function provided

PP0 Parallel poll function not provided

DT1 Device trigger function provided

DC1 Device clear function provided

C0 Controller function not provided

2.2 Serial Polling

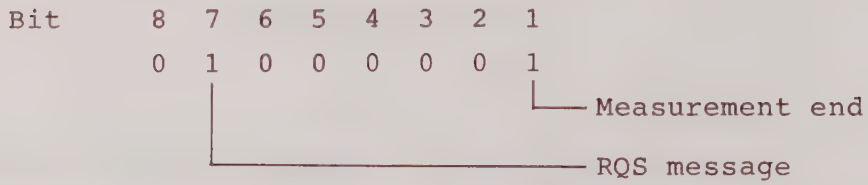
Serial polling refers to generating an interrupt by issuing the SRQ signal to the controller.

The controller requests status bytes to determine whether the talker or listener issued the SRQ signal from the contents of its status bytes.

Bit 7 (RQS message) of the status byte is set to 1 for the talker or listener that issued the SRQ signal.

The other bits indicate the SRQ signal generation status.

The status byte for the MS9001B/B1 is as follows:



When the power is turned on, no SRQ signal is issued. The following messages are necessary to generate the SRQ signal.

SQ1 ... Generates SRQ signal ON

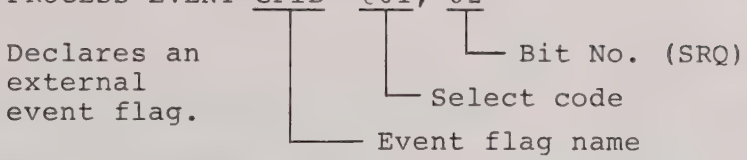
SQ0 ... Does not generate SRQ signal OFF

This function generates an interrupt to inform the controller that the MS9001B/B1 has completed single measurement or fully automatic measurement. In this case, write the program so the controller can process the interrupt.

Note: The end of measurement can also be judged without using this function. (See paragraph 5.32.)

Sample program

```
100  PROCESS EVENT GPIB "@01, 02"
```




```
110  START GPIB

     Declares start of parallel processing

120  CONNECT EVENT GPIB

     Controls external event

130  GO TO 130

     Waits in loop for generation of interrupt

140  END

150  PARACT GPIBSRQ URGENCY 50

     Declares parallel processing start line

160  WAIT EVENT GPIB

     Specifies parallel processing section execution
     scheduling

170  STATUS @108:A

     Reads contents of status register

180  BEEP 1000

190  GO TO 160

200  END PARACT
```

SECTION 3

GP-IB ADDRESS

GP-IB addresses can be set freely by using the dip switch on the rear panel. The address is expressed as a 5-bit binary number. A total of 31 decimal numbers (0 to 30) can be set. All the "1" bits (31 in decimal) cannot be set simultaneously.

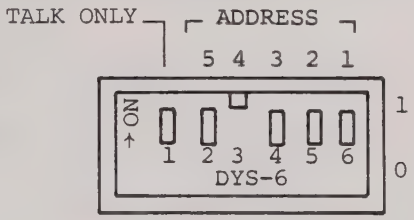


Fig. 3-1 Address Switch

Addresses 1 to 5 correspond to binary numbers $2^0 = 1$, $2^1 = 2$, $2^2 = 4$, $2^3 = 8$, and $2^4 = 16$, respectively when set to position "1".

Switch 1 on the left side is used for TALK ONLY.

When using an external controller, always set it to the lower position (0).

When direct plotting at an external plotter, set it to the upper position (1) (refer to paragraph 3.7.9).

When the MS9001B/B1 is delivered, the 5 switches are pre-set to an address of 8 as shown in Fig. 3-1.

The address indicated by the address switch is only read when the power is turned ON. Therefore, to change an address, always turn the power off before setting the address switch.

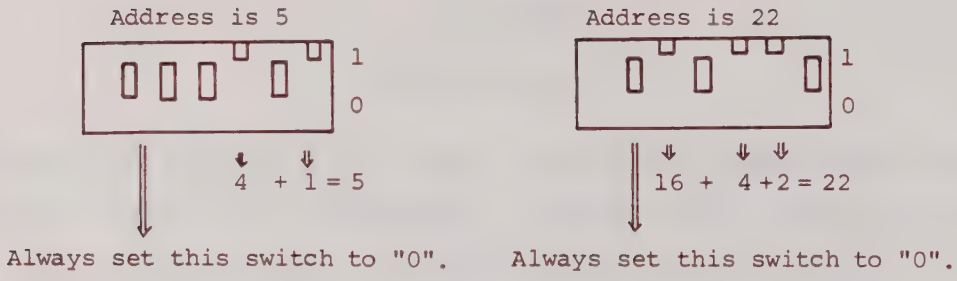


Fig. 3-2 Address Settings

The same address as personal computer address used cannot be used. For example, the address of the Packet V when it is used is 16; 16 cannot be used as the address of the MS9001B/B1. That is, WRITE @116:"SI" is not executed.

SECTION 4

DEVICE MESSAGES

4.1 Explanation of Device Messages

Device messages are commands for controlling the MS9001B/B1 or for data transmission. There are two types of device messages: control messages for controlling the MS9001B/B1, and data request messages for reading the data from the MS9001B/B1. Figure 4-1 is a diagram of the MS9001B/B1 device message syntax.

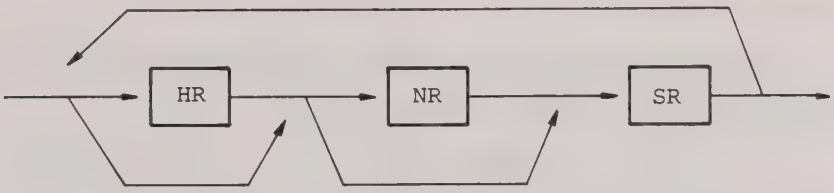


Fig. 4-1 Device Message Syntax

4.1.1 Header (HR) field

The HR field indicates the type and contents of the device message, and appears at the head of the device message. In the MS9001B/B1, the HR field is represented by two or three upper-case letters corresponding to the function indicated on the front panel.

4.1.2 Numeric (NR) field

The NR field is a data field indicating numeric values. The MS9001B/B1 has the following three NR field formats:

1. NR1 format ..... Integer
2. NR2 format ..... Real number
3. NR3 format ..... Exponential

4.1.3 Separator (SR) field

The SR field is a symbol field indicating the end of a data value or a message. The MS9001B/B1 has the following three SR field formats:

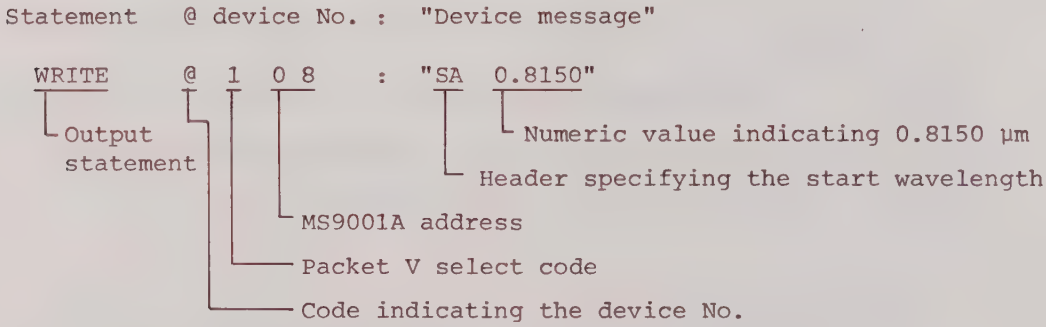
1. SR1 format ..... Comma (,)
2. SR2 format ..... Line feed (LF) or carriage return (CR) and line feed (LF)
3. SR3 format ..... End data byte END

4.2 Sample Programs

This paragraph describes sample programs which control the MS9001B/B1 from the Packet V.

The WRITE or READ statement (general purpose input/output statement of BASIC) is used.

4.2.1 WRITE statement


Statement @ device No. : "Device message"
WRITE @ 1 0 8 : "SA 0.8150"
Output statement
Numeric value indicating 0.8150 µm
Header specifying the start wavelength
MS9001A address
Packet V select code
Code indicating the device No.

At this time, the following data is sent from the Packet V to the MS9001B/B1 in ASCII code.

S	A	0	.	8	1	5	0	CR	LF

4.2.2 Read statement

Statement @ device No. : variable [, variable...]

Note: [ ] indicates omittable

READ @108 : A

- READ: Input statement
- @108: Refer to description of @ device No. in paragraph (1)
- A: Variable

At this time, data is sent from the MS9001B/B1 to the Packet V and assigned to variable A.

Multiple control messages can be sent at one time. At this time, the number of data, including letters, numbers, spaces, commas (,), [CR], [LF], etc., is 64 bytes.

For example, the data which is sent when

WRITE @108:"CT0.85,SP5,....,WA0.849"

62 bytes

is

C	T	0	.	8	5	,	.....	.	8	4	9	CR	LF
1	2	3	4	5	6	7		59	60	61	62	63	64

The MS9001B/B1 receives this data and is operated.

Since the MS9001B/B1 will not operate if more data this is sent, send the data in two parts.

Sample program 1

```
10   WRITE @108:"CT0.85,SP5, ... ,WA0.849"
20   WRITE @108:"WB0.851,LA-15,LB-18"
```

Note: Operation may not be performed normally if another control message is sent after the following control messages.

SI	Single sweep measurement
RP	Repeated sweep measurement
AT	Automatic spectrum masurement
CP	Start copy
FE	Copy paper feed

Sample program 2 (bad example)

```
      ⟨
     100  WRITE @108:"SI,CP"
```

Sample program 3 (bad example)

```
      ⟨
     200  WRITE @108:"CP,FE5"
```

SECTION 5

DEVICE MESSAGE DETAILS

5.1 START

(1) Control message

SAm: Sets the minimum value of the measurement wavelength (start wavelength).

m: 0.6000 to 1.7500

Sample Program

```
10   WRITE @108:"SA0.8150"
                  |  |
                  |  └─ 0.8150 µm
                  └──── Specifies START
```

When this program is run, the start wavelength is set to 0.8150 µm.

This is the same as if

[START] [0] [.] [8] [1] [5] [0] [µ] is keyed in.

(2) Data request message

SAR: Requests the start wavelength data.

Sample program

```
200  WRITE @108:"SAR"
```

This statement, when executed, prepares to output the start wavelength data.

```
210  READ @108:A
```

This statement, when executed, outputs the start wavelength data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Start wavelength data example

0.8150 (LF∧END)

5.2 STOP

(1) Control message

SOk: Sets the maximum value of the measurement wavelength (stop wavelength).

k	Measurement wavelength width
0	1,200 (nm)
1	1,000
2	500
3	200
4	100
5	50
6	20
7	10
8	5
9	2
10	1
11	0

The stop wavelength is set by code (k). The stop wavelength is the sum of the start wavelength added to the wavelength width indicated by this code (k).

Sample program 1

```
10   WRITE @108:"SO3"
20   END
```

When this program is run, the stop wavelength is the sum of 200 nm added to the start wavelength.

This is the same as if the rotary knob is turned after pressing the [STOP] key.

Sample program 2

```
10   WRITE @108:"SA0.8150,SO4"
```

When this program is run, start wavelength 0.815 μm and stop wavelength 0.915 μm (0.815 + 0.1) are set.

This resembles SPAN described in paragraph 5.4, but is a little different, so when using STOP, set the stop wavelength together with the start wavelength.

(2) Data request message

SOR: Requests the stop wavelength data.

Sample program

```
200  WRITE @108:"SOR"
```

This statement, when executed, prepares to output the stop wavelength data.

```
210  READ @108:A
```

This statement, when executed, outputs the stop wavelength data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Stop wavelength data example

0.9155 (LF∧END)

Note:

The stop wavelength is set by code at the control message, but read by actual numeric value at the data request message.

5.3 CENTER

(1) Control message

CTm: Sets the center value of the measurement wavelength (center wavelength).

m: 0.6000 to 1.7500

Sample program

```
10   WRITE @108:"CT0.8150"
```

- CT: Specifies CENTER
- 0.8150: 0.8150 µm

When this program is run, the center wavelength is set to 0.8150 µm.

This is the same as if [CENTER] [0] [.] [8] [1] [5] [0] [µ] is keyed-in.

(2) Data request message

CTR: Requests the center wavelength data.

Sample program

```
200  WRITE @108:"CTR"
```

This statement, when executed, prepares to output the center wavelength data.

```
210  READ @108:A
```

This statement, when executed, outputs the center wavelength data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Center wavelength data example

0.8154 (LF∧END)

5.4 SPAN

(1) Control message

SPk: Sets the measurement wavelength width (span).

k	Span
0	1,200 (nm)
1	1,000
2	500
3	200
4	100
5	50
6	20
7	10
8	5
9	2
10	1
11	0

The span is set by code (k). The center wavelength is unchanged.

The start wavelength is the difference of 1/2 of the span indicated by this code (k) subtracted from the center wavelength. The stop wavelength is the sum of 1/2 of the span indicated by this code (k) added to the center wavelength.

Sample program 1

```
10   WRITE @108:"SP5"
```

Code indicating 50 nm

Specifies SPAN

When this program is run, the span is set to 50 nm. This is the same as if the rotary knob is turned after pressing the [SPAN] key.

Sample program 2

```
10   WRITE @108:"CT0.8, SP5"
```

When this program is run, center wavelength 0.8 µm and span 50 nm are set. As a result, the start wavelength becomes 0.775 µm (0.8 - 0.025) and the stop wavelength becomes 0.825 µm (0.8 + 0.025).

This method is convenient when measuring the spectrum of LDs, LEDs, etc.

This resembles STOP described in paragraph 5.2, but is a little different, so when using SPAN, set the start and stop wavelengths together with the center wavelength.

(2) Data request message

SPR: Requests the data of the code indicating the measurement wavelength span.

Sample program

```
200  WRITE @108:"SPR"
```

This statement, when executed, prepares to output the data of the code indicating the span.

```
210  READ @108:A
```

This statement, when executed, outputs the data of the code indicating the span and assigns it to variable A.

Data format is [NR1] and [SR3]. There is no header.

Example of data of code indicating the span

4 (LF∧END)

The numeric value of the code indicating the span is the same as the code of the control message. When the data is 4, the span is read as 100 nm.

Or the span is found by actual numeric value by calculating the difference between the stop wavelength and start wavelength.

5.5 PEAK → CENTER

(1) Control message

PC: Sets the peak wavelength value as the center wavelength.

Sample program

```
10  WRITE @108:"PC"
```

This statement, when executed, finds the wavelength with the highest level and sets it as the center wavelength.

This is the same as if the [PEAK → CENTER] key is pressed.

(2) Data request message

PCR: Requests the wavelength value of the center wavelength. It is the same as CTR.

Sample program

```
200  WRITE @108:"PCR"
```

This statement, when executed, prepares to output the center wavelegnth value data.

```
210  READ @108:A
```

This statement, when executed, outputs the center wavelegnth value data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Center wavelength value data example

0.8155 (LF∧END)

5.6 MARKER → CENTER

(1) Control message

MC: Sets the main marker wavelength value as the center wavelength.

Sample program

```
10  WRITE @108:"MC"
```

This statement, when executed, makes the main marker wavelength value the center wavelength.

This is the same as if the [MARKER → CENTER] key is pressed.

(2) Data request message

MCR: Requests the wavelength value of the center wavelength. It is the same as CTR.

Sample program

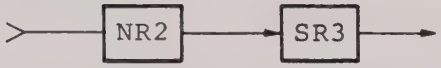
```
200  WRITE @108:"MCR"
```

This statement, when executed, prepares to output the center wavelegnth value data.

```
210  READ @108:A
```

This statement, when executed, outputs the center wavelegnth value data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.



Center wavelength value data example

0.8155 (LF∧END)

5.7 ΔW → SPAN

(1) Control message

WS: Sets the area between wavelength marker 1 and wavelength marker 2 as the span.

Sample program

```
10  WRITE @108:"WS"
```

This statement, when executed, sets the wavelength span by expanding the area between wavelength marker 1 and wavelength marker 2.

This is the same as if the [ΔW → SPAN] key is pressed.

5.8 RESOLUTION

(1) Control message

REk: Sets the resolution.

k	Resolution
1	5 (nm)
2	2
3	1
4	0.5
5	0.2
6	0.1

The resolution is set by code (k).

Sample program

```
10   WRITE @108:"RE4"
                   └── Code indicating 0.5 nm
```

When this program is run, the resolution is set to 0.5 nm.

This is the same as if the rotary knob is turned after pressing the [RESOLUTION] key.

(2) Data request message

RER: Requests the data of the code indicating the resolution.

Sample program

```
200  WRITE @108:"RER"
```

This statement, when executed, prepares to output the data of the code indicating the resolution.

```
210  READ @108:A
```

This statement, when executed, outputs the data of the code indicating the resolution and assigns it to variable A.

Data format is [NR1] and [SR3]. There is no header.

Example of data of code indicating the resolution

```
5 (LF∧END)
```

The numeric value of the code indicating the resolution is the same as the code of the control message. When the data is 5, the resolution is read as 0.2 nm.

5.9 LINEAR

5.9.1 In case of spectrum measurement or display setting

(1) Control message

LIk Sets the linear scale range.

k	Linear scale range at spectrum measurement	k	Linear scale range at spectrum measurement
0	100 (mW)	16	500 (nW)
1	50	17	200
2	20	18	100
3	10	19	50
4	5	20	20
5	2	21	10
6	1 (mW)	22	5
7	500 (µW)	23	2
8	200	24	1 (nW)
9	100	25	500 (PW)
10	50	26	200
11	20	27	100
12	10	28	50
13	5	29	20
14	2	30	10
15	1 (µW)		

The linear scale range is set by code (k).

Sample program

```
10   WRITE @108:"LI9"
```

LI9" — Code indicating 100 µW; LI — Specifies LINEAR

When this program is run, the linear scale range is set to 100 µW.

This is the same as if the rotary knob is turned after pressing the [LINEAR] key.

(2) Data request message

LIR: Requests the data of the code indicating the linear scale range.

Sample program

```
200  WRITE @108:"LIR"
```

This statement, when executed, prepares to output the data of the code indicating the linear scale range.

```
210  READ @108:A
```

This statement, when executed, outputs the data of the code indicating the linear scale range and assigns it to variable A.

Data format is [NR1] and [SR3]. There is no header.

Example of data of code indicating the linear scale range

```
11 (LF∧END)
```

The numeric value of the code indicating the linear scale range is the same as the code of the control message. When the data is 11, the range is read as 20 μW.

5.9.2 Transmission factor measurement or display setting

(1) Control message

LIk: Sets the transmission factor range.

k	Transmission factor
0	100 (%)
1	50
2	20
3	10
4	5
5	2
6	1

The transmission factor range is set by code (k).

Sample program

```
10   WRITE @108:"TR,LI2"
```

- TR: Specifies transmission amount measurement or display (paragraph 5.18)
- LI: Specifies transmission factor
- 2: Code indicating 20%

This statement, when executed, sets the transmission factor range to 20%.

This is the same as turning the rotary knob after pressing the [TRANS] and [LINEAR] keys.

(2) Data request message

LIR: Requests the transmission factor range code data.

Sample program

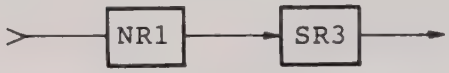
```
      ⟆
200   WRITE @108:"LIR"
```

This statement, when executed, prepares to output the transmission factor range code data.

```
210   READ @108:A
```

This statement, when executed, outputs the transmission factor range code data and assigns it to variable A.

Data format is [NR1] and [SR3]. There is no header.



Transmission factor range code data example

5 (LF∧END)

The value of the transmission factor range code is the same as that of the control message code. When the data is 5, the range is read as 2%.

5.10 EXPAND

(1) Control message

EPk: Sets the linear scale expanded display.

k	Multiplier
0	1
1	1.25
2	1.5
3	1.75
4	2

Sample program

```
10   WRITE @108:"EP3"
```

Indicates x 1.75

Specifies expanded display

When this program is run, the linear scale display is expanded.

This is the same as if the rotary knob is turned after pressing the [EXPAND] key.

5.11 LOG

(1) Control message

LOk: Sets the log scale.

k	Log scale
0	10 (dB/div)
1	5
2	2
3	1
4	0.5
5	0.2

The log scale is set by code (k).

Sample program

```
10   WRITE @108:"LO1"
                  |└─ Code indicating 5 dB/div
                  └── Specifies LOG scale
```

When this program is run, 5 dB/div is set at the log scale.

This is the same as if the rotary knob is turned after pressing the [LOG] key.

(2) Data request message

LOR: Requests the data of the code indicating the log scale.

Sample program

```
200  WRITE @108:"LOR"
```

This statement, when executed, prepares to output the data of the code indicating the log scale.

```
210  READ @108:A
```

This statement, when executed, outputs the data of the code indicating the log scale and assigns it to variable A.

Data format is [NR1] and [SR3]. There is no header.

Example of data of code indicating the log scale

2 (LF∧END)

The numeric value of the code indicating the log scale is the same as the code of the control message. When the data is 2, the log scale is read as 2 dB/div.

5.12 REFERENCE LEVEL

(1) Control message

LVm: Sets the maximum value (reference level) of the log scale display.

m: -80 to +20 (Spectrum)
-40 to +40 (Trans, Loss) } Integer

Sample program 1

```
10   WRITE @108:"LV-15"
```

Indicates -15 dB

Specifies REFERENCE LEVEL

When this program is run, the maximum value of the log scale is set to -15 dB.

This is the same as if the rotary knob is turned after pressing the [REF. LEV] key.

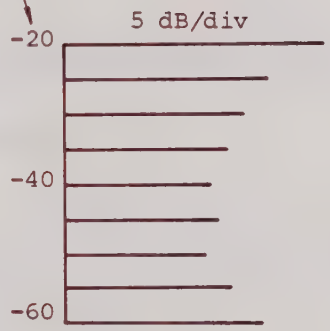
Note:

This message can be used only when the log scale is set. Use this message after setting the log scale with the message of paragraph 5.11 LOG, or after setting the log scale by pressing the [LOG] key.

This message is convenient when used as shown in the sample program 2.

Sample program 2

```
10   WRITE @108:"LO1, LV-20"
```



When this program is run, the scale is set as shown above.

Sample program 3 (bad example)

```
10   WRITE @108:"LV-20, LO1"
```

When this program is run at linear scale, the first LV-20 is ignored and is not set. Pay careful attention to the message sequence.

(2) Data request message

LVR: Requests the data indicating the maximum value of the log scale display.

Sample program

```
200  WRITE @108:"LVR"
```

This statement, when executed, prepares to output the data indicating the maximum value of the log scale display.

```
210  READ @108:A
```

This statement, when executed, outputs the data indicating the maximum value of the log scale and assigns it to variable A.

Data format is [NR1] and [SR3]. There is no header.

Data example

```
-15 (LF∧END)
```

5.13 PEAK → LEVEL

(1) Control message

PL: Sets the level scale to match the peak value.

Sample program

```
10   WRITE @108:"PL"
```

This statement, when executed, sets the level scale matched to the peak value.

This is the same as if the [PEAK → LEVEL] key is pressed.

5.14 HIGH SENSITIVITY

(1) Control message

HIj: Switches the sensitivity.

j	Sensitivity
0	Normal sensitivity
1	High sensitivity

Sample program

```
10   WRITE @108:"HI1"
```

Specifies high sensitivity

Specifies sensitivity switching

This is the same as if switched by pressing the [HIGH SENSITIVITY] key.

5.15 AVERAGE TIME

(1) Control message

AVm: Sets the number of averaging times.

m: 1 to 1000 (Integer)

Sample program

```
10   WRITE @108:"AV10"
```

Indicates 10 times

Specifies averaging

When this program is run, the number of averaging times is set to 10.

This is a little different from turning the rotary knob after pressing the [AVERAGE TIME] key.

When using the rotary knob, the number of averaging times can be set to 1, 2, 5, 10, 20, 50, 100, 200, 500 or 1000 only.

5.16 SWEEP TIME

(1) Control message

SWj: Switches the sweep time.

j	Sweep time
0	Normal
1	Short (fast)

Sample program

```
10   WRITE @108:"SW1"
```

Switch indicating short time (fast) sweep

Specifies sweep time switching

This statement, when executed, switches the sweep time to short time (fast).

This is the same as if the [SWEEP TIME] key is pressed.

5.17 SPECTRUM

(1) Control message

SR: Sets spectrum measurement and display.

Sample program

```
10   WRITE @108:"SR"
```

This statement, when executed, sets spectrum measurement and display.

This is the same as if the [SPECTRUM] key is pressed.

5.18 TRANSMISSION

(1) Control message

TR: Sets transmission amount measurement or display.

Sample program 1

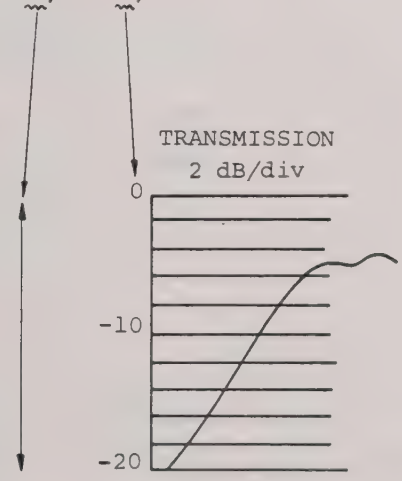
```
10   WRITE @108:"TR"
```

When this program is run, transmission measurement is set.

This is the same as if the [TRANS] key is pressed.

Sample program 2

```
10   WRITE @108:"TR, LO2, LV0, GD"
```



When this program is run, transmission measurement is set by TR as shown above. Next, the scale is set by LO2 and LV0.

The graph is displayed by the last GD.

Sample program 3 (bad example)

```
10   WRITE @108:"LO2, TR, LV0, TR"
```

Since this program does not set the log scale after transmission measurement is set by TR, the result may not be the same as that of sample program 2.

5.19 LOSS

(1) Control message

LS: Sets transmission loss measurement or display in log scale mode only.

Sample program 1

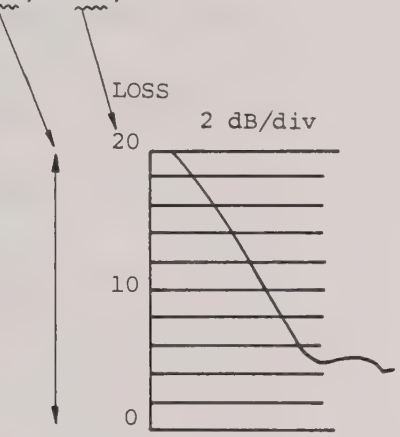
```
10   WRITE @108:"LS"
```

When this program is run, transmission loss measurement is set.

This is the same as if the [LOSS] key is pressed.

Sample program 2

```
10   WRITE @108:"LO2,LS,LO2,LV20,GD"
```



When this statement is executed, the first LO2 sets the log scale, then LS sets transmission loss measurement.

The next LO2 and LV2 set the scale.

GD displays a graph.

Sample program 3 (bad example)

```
10   WRITE @108:"LO2,LS,LV20,GD"
```

Since this program does not set the log scale after transmission loss measurement is set by LS, the result may not be the same as that of sample program 2.

5.20 GRAPH DISPLAY

(1) Control message

GD: Sets graph display.

Sample program

```
10   WRITE @108:"GD"
```

This statement, when executed, displays a graph.

This is the same as if the [GRAPH DISPLAY] key is pressed.

5.21 DATA MEMORY

(1) Control message

DMn: Sets data memory n and specifies spectrum measurement.

n	Data memory
1	DATA 1
2	DATA 2
3	DATA 3

Sample program

```
10   WRITE @108:"DM3"
                 └── Indicates data memory
```

When this program is executed, the data memory is set to DATA3.

This is the same as if the [DATA3] key is pressed.

(2) Data request message (1)

DMRn: Requests the measured data stored at data memory n.

n	Data memory
1	DATA 1
2	DATA 2
3	DATA 3

Sample program 1

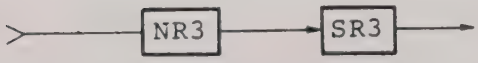
```
      ⟆
300   WRITE @108:"DMR2"
```

This statement, when executed, prepares to output the measured data stored at data memory 2. One data of the position indicated by the numeric value of the point counter (corresponding to 0 to 500 points) is prepared and the value of the point counter is incremented by one.

```
310   READ @108:D1
```

This statement, when executed, outputs the measured data.

Data format is one [NR3] and [SR3]. There is no header.



Measured data example

+0.4765E-3 (LF∧END)

The correspondence between the scale value and measured data is shown below.

Scale value	Measured data
1 mW	1.0000E-0
1 µW	1.0000E-3
1 nW	1.0000E-6
35 µW	0.3500E-1
245 nW	0.2450E-3

Notes:

1. When measurement are made in log scale, log data is output.
2. Since one measured data is output, the READ statement has one variable (D1 in the sample program 1).

Note 2. (Cont'd)

Sample program 2

```
                                  The measured data is made y (x).

                                  x is 0 to 500 and corresponds to the point
                                  counter.

                                  y (0) corresponds to the measured data of
                                  start wavelength.

                                  y (250) corresponds to the measured data of
                                  center wavelength.

200 DIM Y (500)                   y (500) corresponds to the measured data of
                                  stop wavelength.

210  WRITE @108:"DM1"             Sets data memory 1 (DATA1)
220  WRITE @108:"SI"              Starts measurement
                                  The point counter is cleared to 0.

230  WAIT DELAY 0.5               Waits 0.5 seconds ┐
                                                     ├ (See paragraph
240  WAIT DELAY 0.1               Waits 0.1 seconds ┘ 5.33 (2) Note.)

250  WRITE @108:"STR"             Requests data indicating sweep measurement
                                  status for measurement end judgement

260  READ @108:A                  1, if measuring;  0, if measurement end.

270  IF A=0 THEN 280 ELSE 240     If A=0, go to 280, if A≠0, go to 240.

280  WRITE @108:"DMR1"            Requests measured data.
                                  Since the point counter indicates 0,
                                  the prepared data is y (0).
                                  The point counter is incremented by one
                                  and indicates 1.

290  READ @108:D1                 Assigns D1=y(0)

300  LET Y(0)=D1

360  WRITE @108:"DMR1"            Requests measured data.
                                  Since the point counter indicates 1,
                                  the prepared data is y (1).
                                  The point counter is incremented by one and
                                  indicates 2.
```

Note 2. (Cont'd)

```
370  READ @108:D1              Assigns D1=y(1)
380  LET Y(1)=D1
```

The measured data is read by repeating this.

If READ @108:D1 is executed without executing a WRITE @108:"DMR1" data request, the preceding data is read again.

```
280  FOR I=0 TO 500 STEP1
290  WRITE @108:"DMR1"
300  READ @108:Y(I)
370  NEXT I
```

Note 3.

The point counter is cleared to 0 in the following cases;

1. WRITE @108:"SI" is executed.
2. WRITE @108:"DMRn" is executed to change data memory number.

The point counter determines the point of the data to be output from the measured data for 501 points, it is inside the MS9001B/B1 and is automatically incremented by 1 when a data request message is received.

When the SINGLE control message described in paragraph 5.30 is executed, the point counter is cleared to 0.

The point counter is also cleared to 0 when the data memory number (DATA1 to DATA3) is changed. For example, as in sample program 3 below.

Note 3. (Cont'd)

Sample program 3

```
290  FOR I=0 TO 299 STEP1
300  WRITE @108:"DMR2"
310  READ @108:D1
320  NEXT I
```

Up to this statement, the measured data for 300 points are output and the point counter becomes 300.

```
330  FOR I=0 TO 199 STEP1
340  WRITE @108:"DMR3"
```

Since the point counter is cleared to 0 the first time this statement is executed, the measured data of data memory 3 can be read from the point 0 position.

```
350  READ @108:D1
360  NEXT I
```

This reads the measured data of data memory 2 from points 0 to 299 and the measured data of data memory 3 from points 0 to 199.

(3) Data request message (2)

DQRn: Requests the measured data of data memory n.

n	Data memory
1	DATA 1
2	DATA 2
3	DATA 3

Sample program 1

```
100  DIM D(500)
110  WRITE @108:"DQR1"
```

This statement, when executed, prepares to output the measured data stored in data memory 1 so that it can be read by the MAT READ statement of the Packet V.

```
120  MAT READ @108:D
```

This statement, when executed, reads the measured data of 501 points.

Data format is 501 [NR3]s and [SR3].

Measured data example

```
0.3745E-3, 0.6837E-3, 0.1926E-2, ....
0.3758E-3 (LF^END)
```

Data of point 501-th

5.22 GRAPH & MARKER CLEAR

(1) Control message

CL: Clears the marker. When the marker is cleared, clears the waveform graph.

Sample program

```
10   WRITE @108:"CL, CL"
```

This statement, when executed, clears the waveform and marker on the CRT.

This is the same as if the [GRAPH & MARKER CLEAR] key is pressed.

5.23 MAIN MARKER

(1) Control message

MMℓ: Sets the main marker.

ℓ: -0.6000 to 1.7500

Start wavelength ≦ ℓ ≦ Stop wavelength

Sample program

```
10   WRITE @108:"MM0.8475"
```

This statement, when executed, sets the main marker to 0.8475 μm and displays it on the CRT.

This is the same as if [MAIN MARKER] [0] [.] [8] [4] [7] [5] [μ] is keyed-in..

(2) Data request message

MMR: Requests the main marker wavelength value data.

Sample program

```
400  WRITE @108:"MMR"
```

This statement, when executed, prepares to output the main marker wavelength value data.

```
410  READ @108:A
```

This statement, when executed, outputs the main marker wavelength value data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Wavelength value data example

0.8475 (LF∧END)

5.24 LEVEL MARKER 1

5.24.1 Linear scale setting

(1) Control message

LAℓ: Sets level marker 1.

ℓ: 0.00 to 1000.00

ℓ has the following limitation:

Level marker 2 ≦ ℓ: Level marker 1 ≦ Linear scale range

However, 1 (mW), 1 (μW), and 1 (nW) are read as 1000 (μW), 1000 (nW), and 1000 (PW), respectively.

Subscripts μ, n, and P are not considered.

This setting is also performed with NR1 format data.

Sample program

```
10   WRITE @108:"LI6,LA970"
```

This statement, when executed, sets the linear scale to 1 (mW) and the level marker to 970 (μW) and displays it on the CRT.

This is the same as if the rotary knob is turned after pressing the [LEVEL] key.

Note: This is not executed when the transmission factor measurement or display is set by the [TRANS] key.

(2) Data request message

LAR: Requests the level marker 1 level value data.

Sample program

```
300  WRITE @108:"LAR"
```

This statement, when executed, prepares to output the level marker 1 level value data.

```
310  READ @108:A
```

This statement, when executed, outputs the level value data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Level value data example

```
970 LF∧END
```

5.24.2 In case of log scale setting

(1) Control message

LAℓ: Sets level marker 1.

ℓ: -80.00 to 20.00

ℓ has the following limitation:

Level marker 2 or
Log scale display minimum value ≦ ℓ: Level marker 1 ≦ Log scale display maximum value (reference level)

Sample program

```
10   WRITE @108:"LA-24.55"
```

This statement, when executed, sets the level marker 1 to -24.55 dB and displays it on the CRT.

This is the same as if the rotary knob is turned after pressing the [LEVEL] key.

(2) Data request message

LAR: Requests the data of level marker 1.

Sample program

```
      ⟩
300  WRITE @108:"LAR"
```

This statement, when executed, prepares to output the level marker 1 data.

```
310  READ @108:A
```

This statement, when executed, outputs the level value data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Data example

-24.55 (LF∧END)

5.25 LEVEL MARKER 2

5.25.1 Linear scale setting

(1) Control-message

LMℓ: Sets level marker 2.

ℓ: 0.00 to 1000.00

ℓ has the following limitation:

ℓ: Level marker 2 ≦ Level marker 1 ≦ Linear scale range

However, 1 (mW), 1 (μW), and 1 (nW) are read as 1000 (μW), 1000 (nW), and 1000 (PW), respectively.

Subscripts μ, n, and P are not considered.

This setting is also performed with NR1 format data.

Sample program

```
10   WRITE @108:"LI6,LM485"
```

This statement, when executed, sets the linear scale to 1 (mW) and the level marker to 485 (μW) and displays it on the CRT.

This is the same as if the rotary knob is turned after pressing the [LEVEL] key.

Note: This is not executed when the transmission factor measurement or display is set by the [TRANS] key.

(2) Data request message

LMR: Requests the level marker 2 level value data.

Sample program

```
300  WRITE @108:"LMR"
```

This statement, when executed, prepares to output the level marker 2 level value data.

```
310  READ @108:A
```

This statement, when executed, outputs the level value data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Level value data example

485 (LF∧END)

5.25.2 Log scale setting

(1) Control message

LMℓ: Sets the level marker 2.

ℓ: -80.00 to 20.00

ℓ has the following limitation:

Log scale display minimum value ≦ ℓ: Level marker 2 ≦ Level marker 1 ≦ Log scale display minimum value (reference level)

Sample program

```
10   WRITE @108:"LM-27.55"
```

This statement, when executed, sets the level marker 2 to -27.55 dB and displays it on the CRT.

This is the same as if the rotary knob is turned after pressing the [LEVEL] key.

(2) Data request message

LMR: Requests the data of level marker 2.

Sample program

```
300  WRITE @108:"LMR"
```

This statement, when executed, prepares to output the level marker 2 data.

```
310  READ @108:A
```

This statement, when executed, outputs the level value data and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Data example

-27.55 (LF∧END)

5.26 WAVELENGTH MARKER 1

(1) Control message

WAℓ: Sets wavelength marker 1.

ℓ: 0.6000 to 1.7500

Start wavelength ≦ ℓ ≦ Wavelength marker 2

Sample program

```
10   WRITE @108:"WA0.8475"
```

When this program is run, wavelength marker 1 is set to 0.8475 μm and displayed.

This is the same as if
[WAVE-1] [0] [.] [8] [4] [7] [5] [μ] is keyed-in.

(2) Data request message

WAR: Requests the data of wavelength marker 1.

Sample program

```
400  WRITE @108:"WAR"
```

This statement, when executed, prepares to output the data of wavelength marker 1.

```
410  READ @108:A
```

This statement, when executed, outputs the data of wavelength marker 1 and assigns it to variable A.

Data format is ⌈NR2⌉ and ⌈SR3⌉. There is no header.

Data example

0.8475 (LF∧END)

5.27 WAVELENGTH MARKER 2

(1) Control message

WBm: Sets wavelength marker 2.

m: 0.6000 to 1.7500

Wavelength marker 1 ≦ m ≦ Stop wavelength

Sample program

```
10   @108:"WB0.8575"
```

When this program is run, wavelength marker 2 is set to 0.8575 μm and displayed.

This is the same as if
⌈WAVE-2⌉ ⌈0⌉ ⌈.⌉ ⌈8⌉ ⌈5⌉ ⌈7⌉ ⌈5⌉ ⌈μ⌉ is keyed-in.

(2) Data request message

WBR: Requests the data of wavelength marker 2.

Sample program

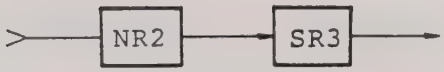
```
      }
     400  WRITE @108:"WBR"
```

This statement, when executed, prepares to output the data of wavelength marker 2.

```
     410  READ @108:A
```

This statement, when executed, outputs the data of wavelength marker 2 and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.



Data example

0.8575 (LF∧END)

5.28 PEAK SEARCH

(1) Control message

PS: Executes peak search in linear scale mode.

When the waveform of a spectrum, etc. is displayed by linear scale, the main marker is set to its peak.

Sample program

```
10   WRITE @108:"PS"
```

When the waveform of a spectrum is displayed by linear scale and this statement is executed, the main marker is set to the peak of the spectrum. The peak wavelength is also displayed as Wp *.****.

This is the same as if the [PEAK SEARCH] key is pressed.

(2) Data request message

PSR: Requests the peak level value data.

Sample program

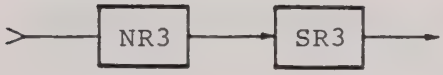
```
200  WRITE @108:"PS,PSR"
```

This statement, when executed, prepares to output the peak level value data.

```
210  READ @108:A
```

This statement, when executed, outputs the peak level value data and assigns it to variable A.

Data format is [NR3] and [SR3]. There is no header.



Data example

0.3756E-02 (LF∧END)

5.29 HALF CENTER

(1) Control message

HC: Displays the main marker at the center of the half-width wavelength.

This is effective only when spectrum measurement is set and a waveform is displayed.

Sample program

```
10   WRITE @108:"HC"
```

This statement, when executed, displays the main marker at the center of the wavelength of the 1/2 peak level (half-width wavelength).

This is the same as if the [HALF CENTER] key is pressed.

(2) Data request message

HCR: Requests the half-width wavelength center value data.

Sample program

```
200  WRITE @108:"HC,HCR"
```

This statement, when executed, displays the main marker at the center of the half-width wavelength, then prepares to output the wavelength value (half-width wavelength center value) data of this main marker.

```
210  READ @108:A
```

This statement, when executed, outputs the center value data of the half-width wavelength and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Data example

0.8150 (LF∧END)

5.30 HALF WIDTH

(1) Control message

HW: Calculates and sets the width of the half-width wavelength.

It is effective when spectrum measurement is set and a waveform is displayed.

Wavelength marker 1 and wavelength marker 2 are set to the minimum value and maximum value of the wavelength showing the 1/2 peak level value, respectively, and the difference between the two wavelength markers is calculated and displayed as the half width value.

Sample program

```
10   WRITE @108:"HW"
```

This statement, when executed, sets waveform marker 1 and waveform marker 2 at the 1/2 peak level and displays the value of (W2-W1) as the half-width wavelength of the waveform.

This is the same as if the [HALF WIDTH] key is pressed.

(2) Data request message

HWR: Requests the (W2-W1) data when the half-width wavelength is calculated and the wavelength markers are set.

Sample program

```
)
300  WRITE @108:"HW,HWR"
```

This statement, when executed, prepares to output the (W2-W1) value.

```
310  READ @108:A
```

This statement, when executed, outputs the prepared data above and assigns it to variable A.

Data format is [NR2] and [SR3]. There is no header.

Half-width wavelength data example

```
45.5 (LF∧END)
```

5.31 SINGLE

(1) Control message

SI: Sets single sweep measurement start.

Sample program

```
10   WRITE @108:"SI"
```

When this program is run, single sweep measurement is performed.

The value of the data memory point counter (see paragraph 5.21) is made 0.

This is the same as if the [SINGLE] key is pressed.

5.32 REPEAT

(1) Control message

RP: Sets repeat sweep measurement start.

Sample program

```
10   WRITE @108:"RP"
```

When this program is run, repeat sweep measurement is performed.

The value of the data memory point counter (see paragraph 5.21) is set to 0.

This is the same as if the [REPEAT] key is pressed.

5.33 STOP (SWEEP MODE)

(1) Control message

ST: Sets sweep measurement stop.

Sample program

```
10   WRITE @108:"ST"
```

When this program is run, sweep measurement stops.

This is the same as if the [STOP] key is pressed.

(2) Data request message

STR: Requests the data indicating the sweep measurement status (executing, stopped).

Data	Status
0	Sweep measurement stopped
1	Single sweep measurement executing
2	Repeat sweep measurement executing

Sample program

```
      }
      500  WRITE @108:"STR"
```

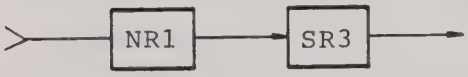
This statement, when executed, prepares to output the data indicating the sweep measurement status.

```
      510  READ @108:A
```

This statement, when executed, assigns the data above to variable A.

This is used for measurement end judgement.

Data format is [NR1] and [SR3]. There is no header.



Data example

1 (LF∧END)

Note:

The MS9001B/B1 begins sweep measurement 0.1 to 1 seconds after WRITE @108:"SI" or WRITE @108:"RP" is executed. If the sweep measurement status is read during this period, the status before measurement is started, is read.

When the sweep measurement status is read, since the MS9001B/B1 temporarily stops measurement and data is transferred with the personal computer, etc., the sweep measurement speed becomes slow.

Sample program (see paragraph 5.21.(2) Note 2)

```
220  WRITE @108:"SI"      Starts measurement
230  WRITE DELAY 0.5      Waits 0.5 seconds
                          Waits required time for sweep
                          measurement
240  WAIT DELAY 0.1       Waits 0.1 seconds
                          Makes interval up to reading
                          of next sweep measurement
                          status 0.1 second.
250  WRITE @108:"STR"     Requests data indicating
                          sweep measurement status
260  READ @108:A          Reads data
270  IF A=0 THEN 280 ELSE 240
     If A=0, since one sweep measurement is
             ended, goes to the next line.
     If A≠0, since MS9001B/B1 is measuring,
             repeats lines 240 to 260 and waits for
             measurement to end.
             If the wait of line 240 is not performed,
             the sweep speed will become extremely
             slow.
280  WRITE @108:"DMR1"    Requests measured data
```

5.34 MARKER/FULL

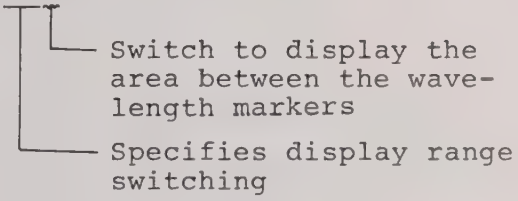
(1) Control message

MFj: Switches the graph display range.

j	Display range
0	Full range
1	Area between wavelength markers 1 and 2

Sample program

```
10   WRITE @108:"MF1"
```



This statement, when executed, displays the area between wavelength markers 1 and 2. It is effective when wavelength markers 1 and 2 are set.

This is the same as if the [MARKER/FULL] key is pressed.

5.35 INITIAL

(1) Control message

IN: Sets the device function to the power ON state.

Sample program

```
10   WRITE @108:"IN"
```

When this program is run, since the device function is set to the power ON state, the measurement conditions and CRT screen are initialized.

Because the interface function does not change, remote/local and other states do not change.

This is a little different from when the power switch is turned off, and then on again.

5.36 SPECTRUM AUTO RANGING

(1) Control message

AT: Sets automatic spectrum measurement.

Sample program

```
10   WRITE @108:"AT"
```

This statement, when executed, starts automatic spectrum measurement.

This is the same as if the [SPECTRUM AUTO RANGING] key is pressed.

Note: If another control message is sent during automatic measurement, operation may not be performed normally. Therefore, control messages other than the following are not accepted during automatic measurement:

ST Stop (measurement stop request)

ATR Automatic measurement status data request described in paragraph (2) below.

(2) Data request message

ATR: Requests the automatic measurement status (executing or ended) data.

Data	Status
0	Ended
1	Executing

Sample program

```
500  WRITE @108:"ATR"
```

This statement, when executed, prepares to output the automatic measurement status data.

```
510  READ @108:A
```

This statement, when executed, outputs the data and assigns it to variable A.

This is used for automatic measurement end judgement.

Data format is [NR1] and [SR3]. There is no header.

Data example

```
1 LF^END
```

Note: It takes 0.5 to 2 seconds for the MS9001B/B1 to start automatic measurement after WRITE @108:"AT" is executed. If the sweep measurement status is read during this time, the status before the start of measurement will be read.

When the automatic measurement status is read, since the MS9001B/B1 temporarily stops automatic measurement and transfers the status data to the personal computer, etc., the automatic measurement speed becomes slow.

Sample program (See paragraph 5.33.(2) Note.)

```
220  WRITE @108:"AT"      Starts automatic measurement
230  WRITE DELAY 2        Waits 2 seconds
                          Waits time required for sweep
                          measurement
240  WAIT DELAY 0.5       Waits 0.5 seconds.
                          Sets next sweep measurement
                          status read interval to 0.5
                          seconds.
250  WRITE @108:"STR"     Requests sweep measurement
                          status data
260  READ @108:A          Reads data
270  IF A=0 THEN 280 ELSE 240
     IF A=0, since automatic measurement is ended, the
             program advances to the line 280.
     If A≠0, since automatic measurement is being
             performed, the program repeats lines 240
             to 260 and waits for the end of automatic
             measurement.
             If line 240 is not executed here, auto-
             matic measurement will become very slow.
280  WRITE @108:"DMR1"    Requests measured data
```

5.37 COPY

(1) Control message

CP: Copies at the built-in printer.

Sample program

```
10   WRITE @109:"CP"
```

When this program is run, copying at the built-in printer begins.

This is the same as if the [COPY] key is pressed.

Note: If another control message is sent after this message, operation may not be performed normally.

Sample program 1 (bad example)

```
200  WRITE @108:"CP,FE5"
```

Sample program 2 (bad example)

```
200  WRITE @108:"CP"
210  WRITE @108:"SI"
```

(2) Data request message

CPR: Requests the data indicating the operating status of the built-in printer.

Data	Status
0	Copy end
1	Copying
2	Lever raised
3	No printer paper
7	No printer

Sample program

```
600  WRITE @108:"CPR"
```

This statement, when executed, prepares to output the data indicating the operating status of the built-in printer.

```
610  READ @108:A
```

This statement, when executed, assigns the data above to variable A. It is used in copy end judgement.

Data format is [NR1] and [SR3]. There is no header.

Data example

1 (LF∧END)

Notes:

1. The built-in printer starts copying approximately 1 second after WRITE @108:"CP" is executed. If the operating status of the printer is read during this period, the status before start copying is read.
2. If read without performing the copy operation, data which may appear to be different from the actual status may be read. For example, if read after the power is turned on, copy end is read even if the lever is raised or there is no printer paper. The operating status (including lever raised on no printer paper, etc.) must be read after copy is executed.
3. If the other control message is sent during copy operation, the MS9001B/B1 may not operate normally. Send the next control message after completion of copy operation.

5.38 FEED

(1) Control message

FEm: Feeds the built-in printer paper.

m: 1 to 9 (Feed length (cm), Integer)

Sample program

```
10   WRITE @108:"FE5"
```

When this program is run, 5 cm of the built-in printer paper is fed.

Note: Send this message after completion of copy operation.

5.39 ANALYSIS

(1) Control messages

AN k, r: (linear scale) This sets the LD spectrum analysis function.

AN k, n: (log scale)

k	Analysis method
0	Release
1	RMS method
2	Envelope method
3	ndB LOSS method

r 0.001 to 0.999 (linear scale)

This sets the level ratio assumed as the spectrum.

Object of analysis is the spectrum having an intensity r or more times as large as the peak value.

n 1 to 25, 27, 30 (log scale)

This executes the same function as above but indicates that the peak value is minus n dB or more.

The same values of r and n are common both to the RMS and n dB LOSS methods. If different values are required, set them each time.

ARk: The wavelength deviation display value is set with RMS method.

k	deviation ratio
0, 1	σ
2	2σ
3	3σ
4	2.35σ

Sample program (RMS method)

```
10 WRITE @108:"AN1, 0.01"
20 WRITE @108:"AR2"
```

This program analyzes a spectrum that has an intensity that is 1/100 or larger than the maximum spectrum intensity when using the RMS method, and displays the center wavelength and wavelength width (standard deviation in statistics) 2σ.

Sample program (Envelope method)

```
10 WRITE @108:"AN2"
```

This program analyzes a spectrum and displays its results using the envelope method.

Sample program (ndB LOSS method)

```
10 WRITE @108:"AN3, 15"
```

This program analyzes and displays the center wavelength and width of spectra whose values are the peak value minus -15 dB or more, as well as the number of spectra using the n dB LOSS method.

(2) Data request message

ANR: This requests data based on the analysis results.

RMS method: Center wavelength and kσ.

Envelope method:
Center wavelength and half-value width

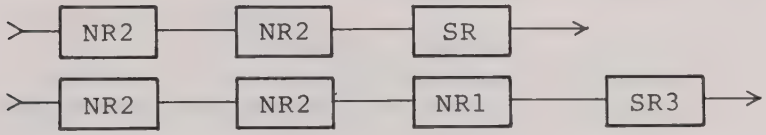
ndB LOSS method:
Center wavelength, spectrum width, and number of spectra

Sample program

```
10 WRITE @108:"AN3, 15"
20 WRITE @108:"ANR"
30 READ  @108:L, D, N
```

This program analyzes the spectra according to the 15 dB LOSS method and assigns the center wavelength to variable L, the spectrum width to D, and the number of spectra to N.

The data format consists of [NR2], [NR1], and [SR3] (without a header).



Data example

0.8475, 7.35, 14 (LF∧END)

This means the center wavelength is 0.8475 μm, the spectrum width is 7.35 nm, and the number of spectra is 14.

5.40 TIME

(1) Control message

TM y. m. d. h. mi:

y	Year (Two low-order digits of Gregorian calendar year)
m	Month
d	Day
h	Hour (24-hour clock)
mi	Minute

Always set each parameter as two digits.

Sample program

```
10 WRITE @108:"TM88.02.05.13.24"
```

* This program sets the clock to 13:24 on February 5, 1988 and displays it on the screen.

5.41 TITLE

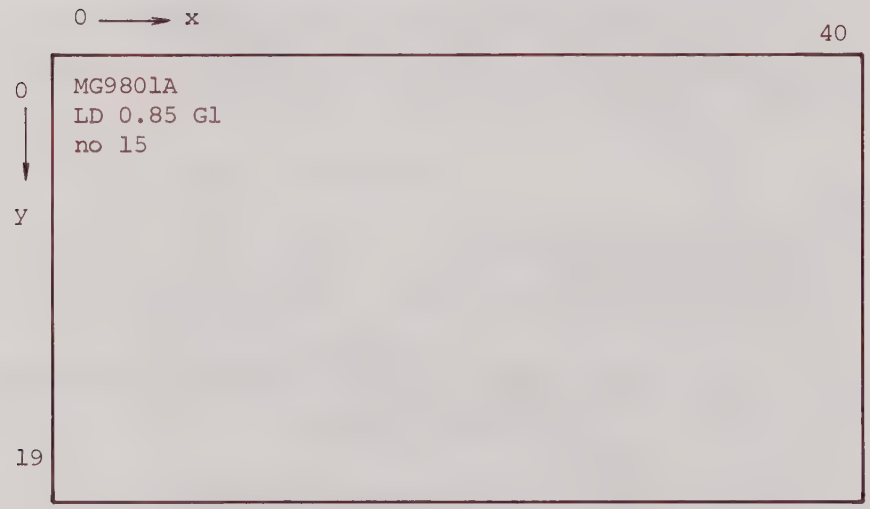
This function displays characters, numbers, and symbols in the graph display area.

(1) Control message

CC,x,y, display characters:

x Integer indicating coordinate x on the CRT: 0 to 40

y Integer indicating coordinate y on the CRT: 0 to 19



Sample program

```
10 WRITE @108:"CC, 0, 0, MG9801A"
20 WRITE @108:"CC, 0, 1, LD 0.85 G1"
30 WRITE @108:"CC, 0, 2, no"&N$
```

Here, &N$ sends character string N$ (converted from numeric variable N) in succession. When N is the integer 15, N$ is a combination of 1 and 5.

This program displays characters and numbers at the upper-left part of the graph area on the CRT.

CE: Erases characters

This specifies that characters displayed in the graph display area by the TITLE function are to be erased.

Sample program

```
10 WRITE @108:"CE"
```

This program erases the characters in the graph display area.

SECTION 6

SAMPLE PROGRAM

6.1 LD Light Source Spectrum

The following program is used to measure the spectrum of the LD light source (MG94B, 0.85 μm) by settig the measurement condition, measurement, reading the measured data, and plotting data.

Displayed screens are also given.

```
10 !************************************************
20 !*                                              *
30 !*      OPTICAL SPECTRUM ANALYZER  MS9001B      *
40 !*          SAMPLE PROGRAM : MS9001B-1          *
50 !*                                              *
60 !************************************************
70  DIM D(500)
80  LET DIV=108
90  LET YM=0
100 WRITE @DIV:"CT0.8435,SP7"
110 WRITE @DIV:"LI10"
120 WRITE @DIV:"RE6"
130 WRITE @DIV:"SI"
140 WAIT DELAY .5
150 WAIT DELAY .1
160 WRITE @DIV:"STR"
170 READ @DIV:A
180 IF A=0 THEN 200 ELSE 150
190 !
200 FOR I=0 TO 500
210   WRITE @DIV:"DMR1"
220   READ @DIV:D(I)
230   PRINT USING "  ###    #.####^^^^ ":I,D(I)
240 NEXT I
250 !
260 FOR I=0 TO 500
270   IF YM<D(I) THEN LET YM=D(I)
280 NEXT I
290 !
300 CLEAR
310 SET VIEWPORT 20,130,35,100
320 SET WINDOW 0,500,0,1
330 SET POSITION 0,0
340 SET LINE STYLE 2
350 PLOT 0,0;500,0;
360 PLOT 500,0;500,1;
370 PLOT 500,1;0,1;
380 PLOT 0,1;0,0;
390 SET POSITION 0,0
400 SET LINE STYLE 1
410 FOR I=0 TO 500
420   PLOT I,D(I)/YM;
430 NEXT I
440 END
```

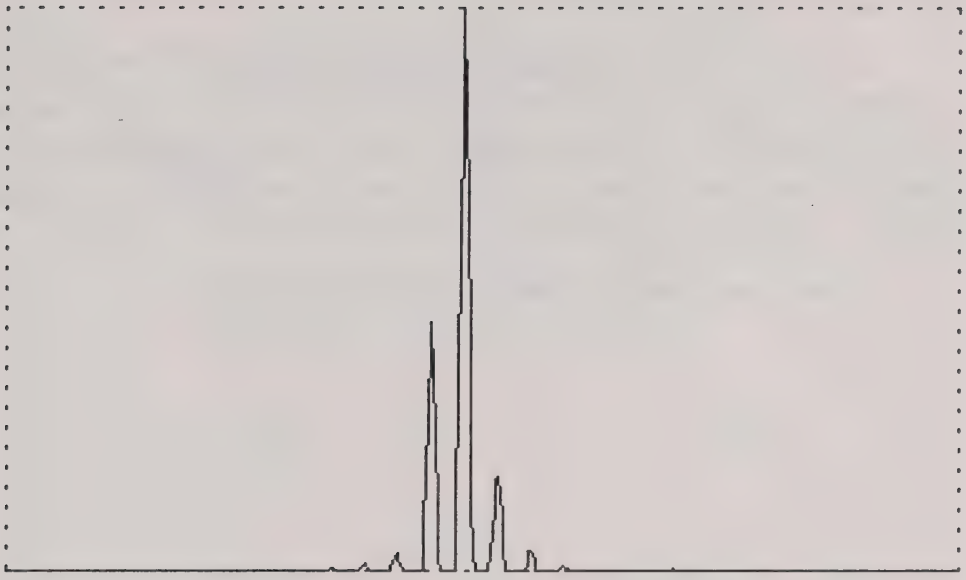


Fig. 6-1 Packet IIe CRT Display

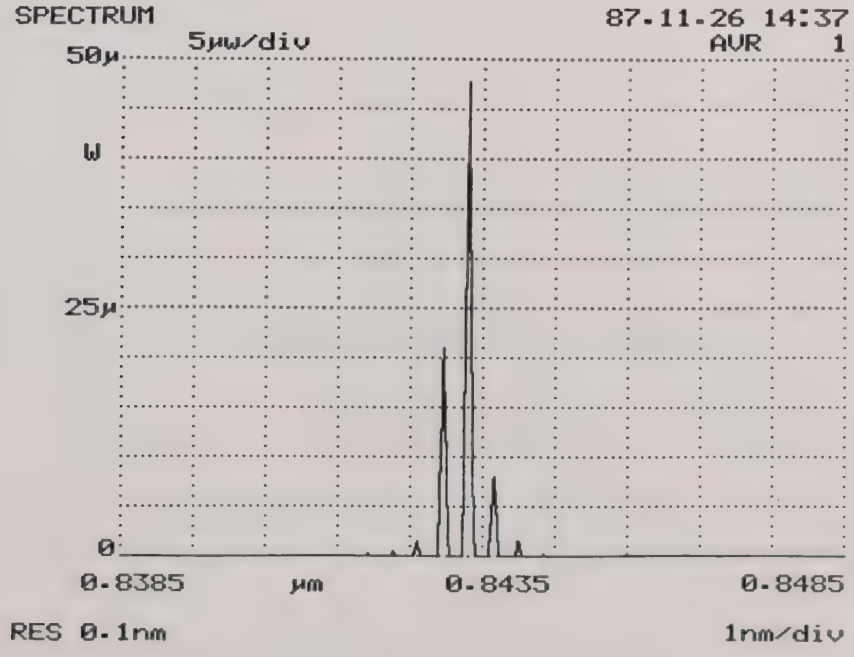


Fig. 6-2 MS9001B/B1 CRT Display

6.2 LD Light Source Spectrum

The following program is used to measure the spectrum of the LD light source (MG94B, 0.85 μm) by setting auto ranging/peak level measurement/half-width measurement, reading measured data of peak wavelength/peak level/half-width, and plotting data.

Displayed screens are also given.

```
 10 !*********************************************
 20 !*                                           *
 30 !*     OPTICAL SPECTRUM ANALYZER  MS9001B    *
 40 !*        SAMPLE PROGRAM : MS9001B-2         *
 50 !*                                           *
 60 !*********************************************
 70  LET DIV=108
 80 !
 90  PRINT "*****************************"
100  PRINT "*                           *"
110  PRINT "* MS9001B SAMPLE PROGRAM *"
120  PRINT "*                           *"
130  PRINT "*****************************"
140  PRINT
150 !
160  WRITE @DIV:"AT"
170  WAIT DELAY 2
180  WAIT DELAY .5
190  WRITE @DIV:"ATR"
200  READ @DIV:A
210  IF A=0 THEN 230 ELSE 180
220 !
230  WRITE @DIV:"PS"
240  WRITE @DIV:"AN1"
250 !
260  WRITE @DIV:"MMR"
270  READ @DIV:MM$
280  WRITE @DIV:"PSR"
290  READ @DIV:PL$
300  WRITE @DIV:"ANR"
310  READ @DIV:AC$,SW$
320 !
330  PRINT " PEAK SPECTRUM VALUE"
340  PRINT "      PEAK WAVELENGTH     "&MM$&CHR$(139)&"m"
350  PRINT "      PEAK LEVEL DATA     "&PL$
360  PRINT
370  PRINT " RMS  ANALYSIS VALUE"
380  PRINT "      CENTER WAVELENGTH   "&AC$&CHR$(139)&"m"
390  PRINT "      SPECTRAL WIDTH      "&SW$&"nm"
400  END
```

```
**************************
*                        *
* MS9001B SAMPLE PROGRAM *
*                        *
**************************

 PEAK SPECTRUM VALUE
      PEAK WAVELENGTH     0.84412μm
      PEAK LEVEL DATA     0.8138E-1

 RMS  ANALYSIS VALUE
      CENTER WAVELENGTH   0.844μm
      SPECTRAL WIDTH      0.29nm
```

Fig. 6-3 Packet IIe CRT Display

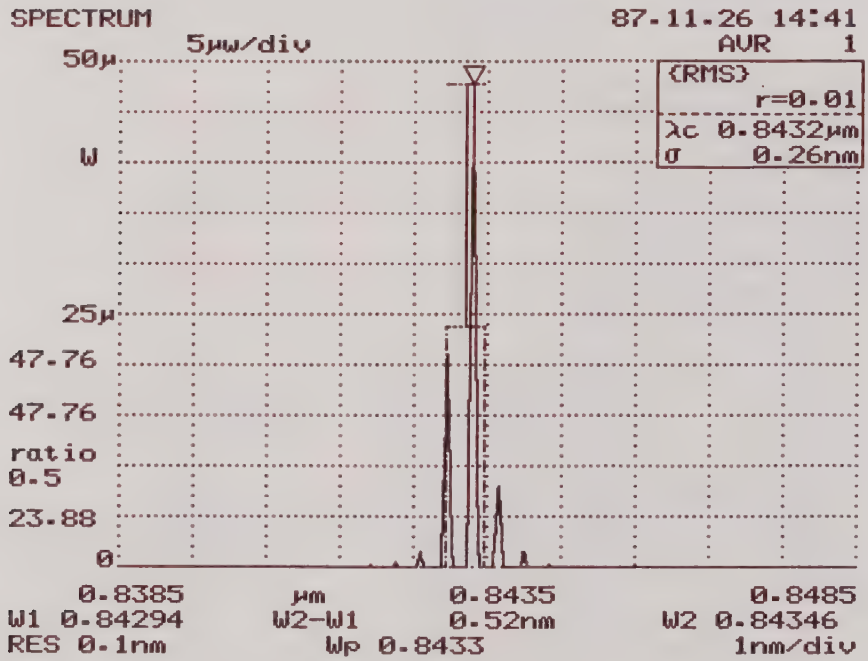


Fig. 6-4 MS9001B/B1 CRT Display

APPENDIX

DEVICE MESSAGE LIST

MEASURE

No.	Function	Header	Numeric Value Example	Numeric Value Contents	Data Request Message
1	START	SA	0.8150	Real number	SAR
2	STOP (wavelength)	SO	2	Code	SOR (1)
3	CENTER	CT	0.8550	Real number	CTR
4	SPAN	SP	5	Code	SPR
*5	PEAK → CENTER	PC	(None)		PCR (wavelength)
*6	MARK → CENTER	MC	(None)		MCR (wavelength)
*7	ΔW → SPAN	WS	(None)		
8	RESOLUTION	RE	4	Code	RER
9	LINEAR	LI	3	Code	LIR
10	EXPAND	EP	3	Code	(None)
11	LOG	LO	1	Code	LOR
12	REF. LEV.	LV	-15	Integer	LVR
*13	PEAK → LEVEL	PL	(None)		
14	HIG. SEN.	HI	1	Switch	
15	AVE. TIM.	AV	10	Integer	
*16	SWEEP TIME	SW	1	Switch	

DISPLAY

No.	Function	Header	Numeric Value Example	Numeric Value Contents	Data Request Message
17	SPECTRUM	SR	(None)		
18	TRANS	TR	(None)		
18	LOSS	LS	(None)		
20	GRAPH DISPLAY	GD	(None)		
21	DATA MEM.	DM	3	No.	{DMR3(2) DQR2
22	GRAPH & MARKER CLEAR	CL	(None)		
23	MAIN MARKER	MM	1.3124 (wavelength)	Real number	MMR
24	LEVEL MARKER 1	LA	35.5	Real number	LAR
25	LEVEL MARKER 2	LM	32.5	Real number	LMR
26	WAVE. 1	WA	0.8475	Real number	WAR
27	WAVE. 2	WB	0.8575	Real number	WBR
28	PEAK SEARCH	PS	(None)		PSR (peak level value)
29	HALF CENTER	HC	(None)		HCR (half-width wavelength center value)
30	HALF WIDTH	HW	(None)		HWR (half-width wavelength)

CONTROL

No.	Function	Header	Numeric Value Example	Numeric Value Contents	Data Request Message
31	SINGLE	SI	(None)		
32	REPEAT	RP	(None)		
33	STOP	ST	(None)		STR
34	MARKER/FULL	MF	1	Switch	
35	INITIAL	IN	(None)		
36	SPECTRUM AUTO RANGING	AT			ATR
37	COPY	CP	(None)		CPR
38	FEED	FE	5	Integer	
39	ANALYSIS	AN	1, 0.01	Integer and Real number	ANR
40	TIME	TM	87....	Integer	
41	TITLE	CC	0,0, AB ...	Integer and characters	
		CE			

Notes:

1. A stop wavelength data request reads the actual wavelength by numeric value.
2. A data request to the data memory reads the measured data.

2. STOP
SOk

k	Measurement wavelength width
0	1,200 (nm)
1	1,000
2	500
3	200
4	100
5	50
6	20
7	10
8	5
9	2
10	1
11	0

4. SPAN
SPk

k	Span
0	1,200 (nm)
1	1,000
2	500
3	200
4	100
5	50
6	20
7	10
8	5
9	2
10	1
11	0

8. RESOLU.
REk

k	Resolution
1	5 (nm)
2	2
3	1
4	0.5
5	0.2
6	0.1

9. LINEAR
LIk

k	Linear scale range at spectrum measurement	Transmission factor
0	100 (mW)	100 (%)
1	50	50
2	20	20
3	10	10
4	5	5
5	2	2
6	1 (mW)	1
7	500 (μW)	
8	200	
9	100	
10	50	
11	20	
12	10	
13	5	
14	2	
15	1 (μW)	
16	500 (nW)	
17	200	
18	100	
19	50	
20	20	
21	10	
22	5	
23	2	
24	1 (nW)	
25	500 (PW)	
26	200	
27	100	
28	50	
29	20	
30	10	

10. EXPAND
EPk

k	Multipler
0	1
1	1.25
2	1.5
3	1.75
4	2

11. LOG
LOk

k	Log scale
0	10 (dB/div)
1	5
2	2
3	1
4	0.5
5	0.2

MP MASTER
MA21788